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Vol. xx FEBRUARY, 1915 No 2

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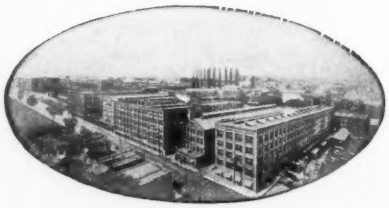
STEAM
SUCTION



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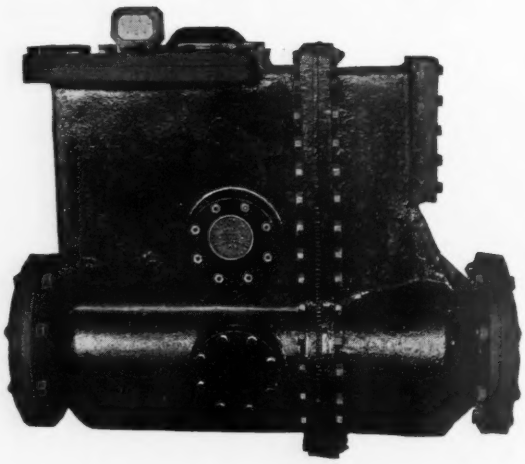

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XX FEBRUARY, 1915 No. 2

FIG. 1. EAST PORTAL.

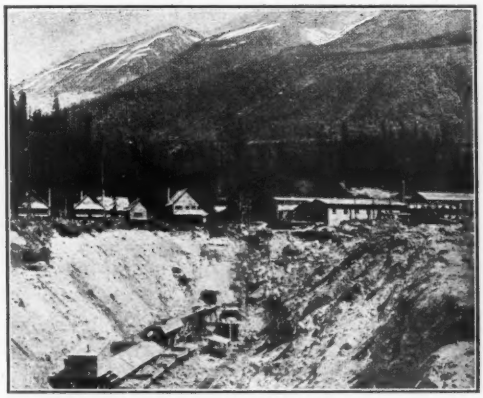


FIG. 2. WEST PORTAL.

MAKING AND BREAKING TUNNEL RECORDS

A double track tunnel five miles long is being driven through the Selkirk mountains, at Rogers Pass, B. C., for the Canadian Pacific Railway. The tunnel forms a portion of a new line construction 18.6 miles long which will bring important advantages. It saves 4.4 miles of actual distance. While it does not reduce the ruling grade of 2.2 per cent, it reduces the length of this grade from 21 to 12 miles on the east approach, and from 25 to 17 miles at the west end. It also eliminates 552 feet of rise and fall and, while the maximum curvature remains 10 degrees, there are only three such curves on the new line in place of a large number on the old line, and 2,600 degrees of central angle is eliminated. The saving in snow sheds, and also in bridges and viaducts is another important feature.

The new construction having been decided upon, the promised saving in operating four to eight transcontinental passenger trains and a dozen through freight trains daily made rapidity of construction imperative, and, as all depended upon the tunnel, time limits were set the contractors with large bonuses for quicker completion.

The tunnel will be one with records of its own in more than one particular. It will be the longest tunnel on the American continent, being more than a quarter of a mile longer than the Hoosac tunnel; also, as will appear, in driving the main tunnel in this case, neither the top heading method, most familiar in American practice, nor the European bottom heading is used, but instead a central heading is driven first with a breaking of the rock all around this center for the full tunnel section.

Another record for this tunnel work is the building of a pioneer parallel tunnel at the contractor's expense with crosscuts into the main tunnel, thus giving more faces to work at, greater facilities for removing the spoil and the general avoidance of the usual delays. That it was a wise expedient the result already shows. By this method work can be

pushed from several faces at once without interference. It is possible also to do all blasting ahead of the shovels, so that they can be operated continuously. Air lines are carried through this pioneer tunnel where there is only slight danger of their being broken; all drainage is removed by the same outlet, that at the west or up grade end being handled by booster pumps, with a portable pump on wheels at the face of the heading.

The construction work was actually begun September, 1913, and it was estimated that by the ordinary methods it would require four years to complete the job, and it appears at the present writing that at least a year of this construction time will be saved.

The pioneer tunnel is 6½ by 9 ft. in section, and is driven from each end, not so that these will ultimately meet, but each about 50 ft. to the right of the main tunnel, and with the floor 7ft. above the final grade. Cross cuts are driven to the center of the main tunnel at intervals of about ¾ mile, and center drifts 11 by 8 ft. are then driven up grade on the center line of the main tunnel, with the bottom of these drifts also 7 ft. above the final grade. The rock is then driled and broken on all sides of the drift, and after shooting the material is loaded by air operated shovels into small cars and removed through the pioneer tunnel. Muck will not be brought out through the pioneer tunnel portals after the full tunnel section has advanced beyond the first crosscut, as the ½ yd. dump cars from the pioneer base can then dump most conveniently into the 12 yd. cars used to serve the steam shovel.

The operations being identical at each end of the tunnel complete duplicate power plants have been installed. At each end ventilation is provided by a Connersville ventilating fan, with a capacity of 3,000 cu. ft. of air per min. This air is delivered through the pioneer tunnel to the various fans in the main bore end to the pioneer heading. A second fan located near the portal of the pioneer heading assists in drawing the foul air out from the fans.

Two Ingersoll-Rand compressors with capacities respectively of 2,200 and 1,100 cu. ft. of free air per min., provide the power for operating drills, shovels and other tools working at 110 lb. pressure. A third compressor with a capacity of 750 cu. ft. compresses air to 1,000 lb. for operating the 16 ton locomotive used in hauling the muck. A similar locomotive, but weighing only 10 tons, is employed at the east or down grade end of the tunnel. All of these various units at each end are driven by five 150 h.p. coal fired boilers.

The rock so far has been schist, slate and quartzite, and it is expected that no other material will be found. The quartzite is extremely hard and drilling progress is slow, although it is advantageously broken up by the powder. The schist, which seems to predominate so far, is comparatively easy to drill, but is so tough that a second shooting is nearly always required.

The full section will be drilled from the center heading by piston drills, but on the pioneer bore, where speed is the primary consideration, Leyner-Ingersoll drills, using 1⅛ in. steel are used exclusively. Leyner drill sharpeners are used with oil furnaces, this fuel being found more economical for the purpose than coal. The shanks are tempered in oil and the bits in water. In the pioneer heading three drills are mounted on a bar, and holes are sunk to a depth of 6 feet. The rounds each have from 22 to 28 shots, and four rounds are usually fired for three eight hour shifts, although five rounds and even six are sometimes fired within the same time. There is no cessation of the work for a minute, day or night or Sunday.

A NEW TIME RECORD.

As might have been expected from the special inducements in the case, the arrangements which these stimulated and the up-to-date apparatus employed, unusual progress is being made in this work. In July, 1914, 715 ft. of pioneer heading was driven at the east end alone. For November, 1914, the advance was as follows:

East end main center heading.....	588 ft.
East end pioneer heading	529 ft.
West end main center heading.....	654 ft.
West end pioneer heading	817 ft.

The last figure given is believed to be the American record of tunnel progress. This pioneer heading was driven down grade through rock that could not be broken over 6 ft. per round. The best day's advance was 37 ft.

In Fig. 2 the advance day by day is plotted to include Dec. 1, which gives a total advance of 852 feet for 31 days. For the 31 days com-

prising the month of December the advance was 852 ft.

The entire line construction is being done for the Canadian Pacific Railway, of which J. G. Sullivan is chief engineer; F. F. Busteed, in charge of construction, British Columbia division, and J. W. Sheppard, assistant engineer in charge at the tunnel. The contract for the tunnel is held by Foley Brothers, Welch & Stewart, for whom A. C. Dennis is superintendent and T. Truran master mechanic. J. Murphy is assistant superintendent in charge at the east portal and J. Fowler assistant superintendent at the west end.

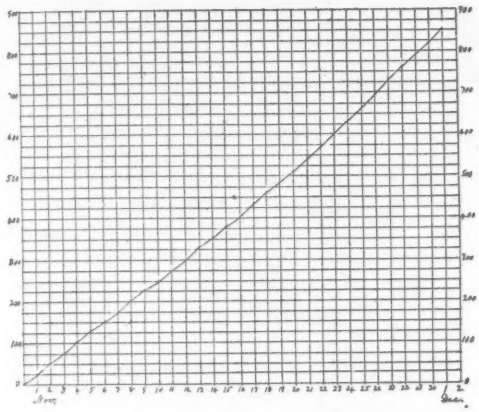


FIG. 3.

THE HIGHEST AND LOWEST TEMPERATURES IN THE ATMOSPHERE

The classic example of extreme hot weather is the temperature reading of 127.4 deg. Fahr., recorded at Ouargla, an oasis in the Algerian Sahara, on July 17th, 1879. It must not be supposed, however, that this is the highest temperature ever known to have occurred in the atmosphere. It is merely the maximum ever measured by the shaded thermometer of a regular meteorological station. In the interior desert region of New South Wales the traveler Stuart once measured 131 degrees in the shade. Griffiths, in his "Travels in Arabia," mentions having observed the heat during land winds to reach 132 degrees in the shade, and 156 degrees in the sun. In this connection it should be remarked that readings of a thermometer "in the sun" are entirely unreliable, because the instrument is directly heated by the sunshine, and no longer records the temperature of the air around it. In the Northern Circars (India) the temperature on one occasion is reported to have stood at 108 degrees at *midnight*, and at 112 degrees at 8 A. M. Night temperatures of 100 degrees and more are common in the Arabian desert. The most extraordinary shade temperature on record is 167 deg. Fahr., said to have been observed in the Desert of Gobi, but this observation is certainly questionable.

LOW TEMPERATURES.

At the opposite end of the scale we have the famous reading of 90.4 deg. below zero Fahr. recorded at Verkhoyansk, Siberia, January 15th, 1885. This often quoted record has, however, been beaten recently at the same place, with a reading of 97.6 degrees below zero. The excessive cold prevailing in this part of Siberia in winter is the more remarkable when we consider that the same region occasionally has temperatures as high as 88 degrees above zero in summer—a range of 186 degrees! The summer is about two months long, and its hot days thaw the ground to a depth of about 3 feet. Verkhoyansk would be uninhabitable in winter, but for the fact that it never experiences much wind at that season. Another "winter cold-pole" appears to lie over Nova Zembla. A minimum thermometer left here by an Austrian expedition in 1872 was found many years later to have registered a temperature of 95.8 degrees below zero. The lowest average temperature throughout the year is found in Antarctica, though the winter temperatures here do not fall so low as those above mentioned. The minimum individual temperature reading thus far reported from the Antartic is 73.3 degrees below zero, observed by Amundsen's expedition on August 13th, 1911.

The absolute minima of temperature heretofore measured in the atmosphere were not, however, found near the earth's surface, but at an altitude of several miles, and the measurements were obtained with self-registering thermometers attached to "sounding balloons." The "record" up to date is 133 deg. below zero Fahr., and, strange to say, this extremely frigid temperature was found about 10 miles above the Island of Java, only a few degrees of latitude from the equator. A temperature of 119 degrees below zero has been measured almost exactly over the equator in Central Africa, at an altitude of 12 miles.—*Scientific American.*

A NEW ENTRY DRIVING MACHINE

BY A. H. GIBSON.

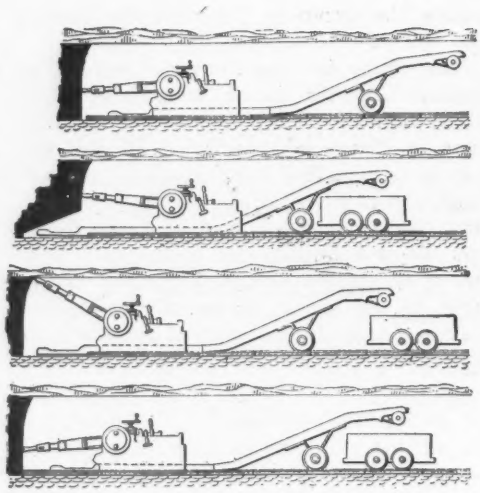
One feature of coal mining which is admittedly dangerous and undesirable is the use of explosives. The only reason for their employment and the risk entailed when they find their way into ignorant or careless hands, is economy. If, however, their use could be entirely eliminated without decrease of output or increase of cost, and without introducing other and perhaps more grave dangers, the safety of coal production would be considerably enhanced, while the occupation of coal mining would become more attractive to the coming generation.

At the present time this improvement in means and methods is applicable to the driving of entries. It is alleged that the Ingersoll-Rand "Heading Machine," "Entry Cutter" or "Cutter and Loader," as it is variously called, accomplishes this result. The machine in question is not new, having been in existence for some six years and having cut many miles of entry. It has now, however, arrived at the status where its endurance, performance and possibilities are known quantities which can be thoroughly proven on a commercial scale.

The principle and operation of this machine may be clearly understood from reference to the accompanying drawings, Figs. 1 to 4. Fig. 1 represents the device ready for undercutting. The machine itself consists of a powerful compressed-air coal puncher mounted upon a carriage and under the control of the operator. A lever elevates or depresses the puncher pick. Another lever moves it from rib to rib by means of a small air engine, while a third lever moves the whole puncher together with its truck bodily toward or away from the face, the conveyor remaining stationary within certain limits or accompanying the forward or backward motion of the puncher as desired.

The puncher itself makes about 160 strokes per minute, and is controlled in the same manner as the ordinary hand-operated machine going from rib to rib and making a cut extending the entire width of the entry.

The conveyor is driven by a separate engine suitably controlled by a stop valve, and the mine car is filled evenly by moving the same about three times during the loading process by means of the brake on the car, provided the latter is on a sufficient grade, that



FIGS. 1, 2, 3, 4.

is, on the dip the car is stopped at the proper place to fill the end nearest the machine first, after which the brake is released, allowing the car to move down hill until the loading is complete.

Fig. 2 shows the machine and entry after undercut is finished, and the conveyor moved into the kerf. This illustration also shows an unfilled car in place and in readiness for the process of knocking down the coal, the car being shown as it would be placed when working on the rise. Making the undercut is the longest part of the operation, requiring from 25 to 40 min., according to the hardness of the coal.

Fig. 3 shows the knocking-down process completed. This ordinarily takes place faster than cars can be supplied. The next operation is to pull the conveyor back about 7 ft., lay a section of track, and move the conveyor forward to position.

Fig. 4 is the same as Fig. 1, except that the entry has advanced about 5 ft. and five to six cars of coal have been loaded out.

THE AVERAGE ADVANCE IS 10 FT.

Two set-ups during the shift constitute a 10-ft. advance of the entry. It is estimated that under suitable operating conditions, such as high coal of the quality found in the Pittsburgh seam, that the machine should average 250-ft. advance per month of 25 working days, working day shift only, night shift being reserved for the laying of tracks, piping, etc.

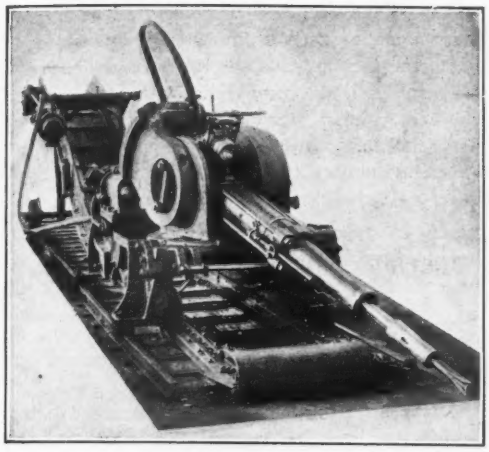


FIG. 5.

Under actual working conditions, the advance made and the repairs show such a speed to be perfectly possible.

Two of these machines which have been in operation at the Annabelle Mine, of the Four States Coal & Coke Co., at Worthington, W. Va., have been in operation since June 1, 1913. These have been operated two shifts of nine hours each per day, and entries cut averaging 10½ to 11 ft. wide and 6½ to 7 ft. high. Where conditions have been suitable and cars have been served to the machine without delay, as much as 20-ft. advance has been made in a single shift. This condition does not, however, hold true all the time, as the machines are considerably delayed by lack of cars, but the average operation over a period of two or three months showed a progress of somewhat over 10 ft. per shift on the average.

The question naturally arises, how does this machine compare with present costs of entry driving? According to conditions, comparisons will vary somewhat, but taking into consideration the first cost of the machines, which work in pairs, the total actual daily expense figures out favorably to the machine, everything being considered. This estimate, however, does not take into account the increased rate of entry driving, the reduced risk of gas or dust explosion, due to the absence of explosives, the fact that a straighter entry is secured, that the roof is better since there is no blasting to shake it loose, also that the ventilation is better due to the straight sides and roof facilitating the movement of the air current.

A reduced risk of explosion is secured by the absence of electric arcs or sparks, and the much ridiculed but nevertheless real menace of live wires strung along the entry, which are, even under the best circumstances, a more or less imminent peril to both men and animals. The advantage of this machine is still more apparent where the roof is bad and requires timbering.

With this, as with other pneumatic mining machines, where gas collects in the entry over night, a small quantity of air may be allowed to escape from the pipings nightly, with the result that in the morning there is no gas and the air at the face is clean and fresh.

SPACING OF BREAKTHROUGHS MAY BE GREATER.

Owing to the ventilating effect of the exhaust air from this machine and the fact that

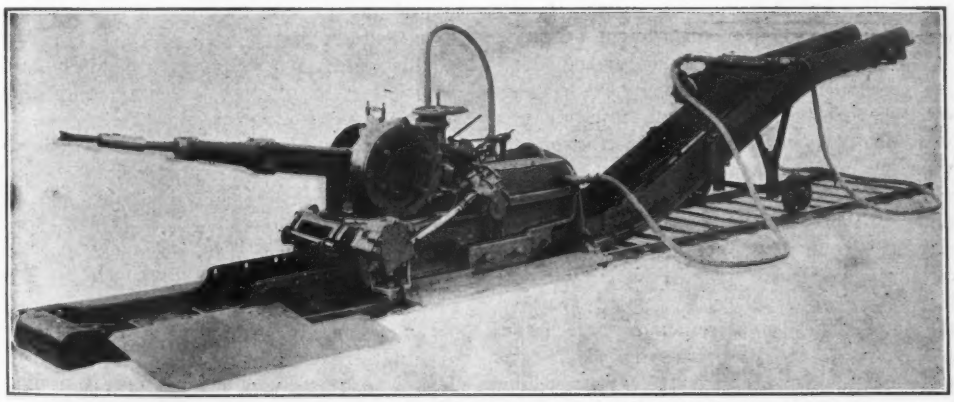


FIG. 6.

this exhaust takes place while work is being done, the distance between breakthroughs prescribed by law could be doubled without seriour danger. This fact reduces this expensive deadwork about half, and allows the entries to proceed more rapidly.

The use of this machine renders possible the working of coal mines by the retreating system, which, should it become general, would effect a considerable saving of human life due to the reduction of accidents from falls of roof. Its use also secures greater uniformity and reliability in daily output than is at present common.

This machine has the disadvantage that when working on the rise a water supply is necessary, which has to be piped to the machine in the same manner as the air line twice each week. The water jet and a beam of light from a safety electric headlight follow the movements of the coal pick, both spray nozzle and headlight being mounted upon the plunger frame and moving with it. Where the entry is on the dip, the coal is usually wet and requires no water spraying.

As has been stated above, this machine has been in operation for about six years. It is, however, only now being placed upon the market. In the operation of the earlier machines, failure and breakages were frequent, and it was found expedient to redesign practically everything on the whole device, after which it was necessary, considering the previous experience, that the redesigned machine should continue for a considerable period of time in operation, to prove beyond doubt that it would stand up to continuous work cutting and loading coal. The success or failure of any mechanical coal cutter depends largely, if not entirely, upon its reliability of operation.

The present machine with its embodied improvements and simple working parts has gone through a severe development, resulting in a steel-inclosed, grease-packed construction, the wear upon which is bound to be extremely small. In the course of driving the several miles of entry in the various mines which this machine has cut, nothing has stopped its advance. Horsebacks have been cut through, large lumps of sulphur have been removed, the entry has been driven under treacherous roof, curves have been cut, and headings as wide as 13 ft. have been made. The machine has also been used in cutting breakthroughs, slate has been cut down and loaded. No accidents have occurred, although the work has been done in gaseous mines with gas issuing from the face most of the time. It is believed, therefore, that compared with the usual method of entry driving, namely undercutting and shooting down, the employment of this machine renders the work at once faster and safer.—*Coal Age.*

SUCTION CONVEYANCE FOR CAST IRON CHIPS

The removal of chips from cylinder-boring machines by the use of suction, or vacuum, is an interesting development in the shops of the Continental Motor Co., of Detroit, Mich., which has been assisted in this work by the American Blower Co., also of Detroit. About six months ago, they installed a No. 3 type-P exhauster to remove chips from two of their cylinder-boring machines. With a six-cylinder automobile engine in place for boring, two aluminum hoods are placed over the valve ports and the chips are drawn through 2½-in. pipes to a separator. This separator is a particularly interesting feature of the installation, as the chips are not carried through the fan but are removed here, where they are at all times easily accessible for cleaning. It is nothing more than a home-made steel-plate box, in the form of a 20-in. cube, arranged with a large horizontal slide in the center, so that it can be divided into two compartments. By closing the slide, the lower half of the box can be emptied while the upper half remains available for collecting chips without interfering in the least with the operation of the system. A 5-in. pipe runs from the top of the box into the main line, which connects with the fan.

This system was designed to handle a maximum of 15 lb. of chips per min., each boring machine having a normal capacity of 6 lb. per min., the additional capacity being allowed for necessary speeding. The velocity through the 2½-in. pipe is approximately 12,000 ft. per min., while the velocity through the 5-in. pipe, which exhausts from the top of the box, is 4,000 ft. per min. The fan runs at 3100 r.p.m. and handles approximately 1200 cu. ft. per min., against a static pressure of 17 in. of water, requiring about 7½ b.hp. to drive This is proving very satisfactory, and there seems no reason why there should not be quite a field for this kind of work.—*Am. Machinist.*

A NEW VOLUME REGULATOR FOR AIR COMPRESSORS

BY RAGNOR WICKANDER.*

The ordinary reciprocating type of air compressors and blowing engines has a displacement proportional to its speed, and the quantity of air pumped varies approximately in the same proportion. In most cases, however, it is desired to regulate the amount of intake air so that it will correspond as nearly as possible to the amount of compressed air consumed, thereby keeping the pressure in the receiver practically constant. A number of regulators, governors or unloaders have been designed for this purpose and the object of this paper is to present a new method serving the same purpose as these devices in a simple and efficient manner, and to demonstrate the principle upon which this method is based.

The operation of this regulator is based upon the following principle: The pressure acting upon and tending to close a suction valve held open by force during the discharge stroke of an air compressor, is proportional to the air pressure created in the cylinder and varies during said stroke, as shown in Fig. 1.

This diagram was taken on a 24 by 14-in. air compressor operating at 50 r.p.m. The valve area of the suction valve, which was held open by force during the discharge stroke, amounting to about 3.5 sq. in., and the average speed of flow of the air through this valve was therefore about 15,000 ft. per min. It is interesting to note how the cylinder pressure increased practically in proportion to the part of the stroke made by the piston.

From this diagram it can be assumed that a closing of the suction valves at an adjustable point of the discharge stroke would be obtained simply by a very gradual regulation of the force holding them open against the action of their springs, and experience corroborates this assumption. In a similar manner a closing of the automatic discharge valves at an adjustable point of the suction stroke can be obtained by the gradual regulation of a force holding them open against the action of their springs.

In the first case the force is so regulated

FIG. 1.

that the suction valves close when the amount of intake air remaining in the cylinder has decreased to correspond to the amount of compressed air desired at the time. In the second case the force is regulated in a way to keep the discharge valves open during such a part of the following suction stroke that the amount of compressed air returned into the cylinder, after expansion to the intake pressure, will leave sufficient room for the desired quantity of fresh air to enter the cylinder during the latter part of the suction stroke.

REGULATION BY ACTION OF THE INLET VALVES.

An application of this regulator to an ordinary poppet valve air compressor, acting upon its inlet valves so as to keep the receiver pressure constant, is shown in Fig. 2. *A* is the compressor cylinder. The inlet valve *B* is provided with a spring which tends to close it, and above is a piston *C* acted upon by pressure from the auxiliary tank *D*. This valve communicates with the atmosphere through the leak *E;* and it also is connected with the main reservoir *F* through the port *G*. This port is closed by means of the pilot valve *H* when the force of the adjustable spring overcomes the air pressure acting on the bottom of the valve piston *I*. An adjustable needle valve *J* can be arranged so as to obtain a constant leak from the main to the auxiliary reservoir, thereby preventing the pressure in the latter from decreasing below a certain valve.

When the compressor is working at a constant partial load the valve *H* will allow some air to enter the auxiliary tank *D*, and the same quantity of air will escape through leak *E*, thereby keeping the pressure in the auxiliary tank acting upon the piston *C* constant. The suction valves will close at such a point of the discharge stroke as to compress exactly the quantity of air consumed, the pressure in the main tank remaining constant.

And increase (or decrease) in the consumption of air will cause a slight momentary decrease (or increase) of the pressure in the

*Abstract of Paper presented at December, 1914, Meeting of the American Society of Mechanical Engineers.

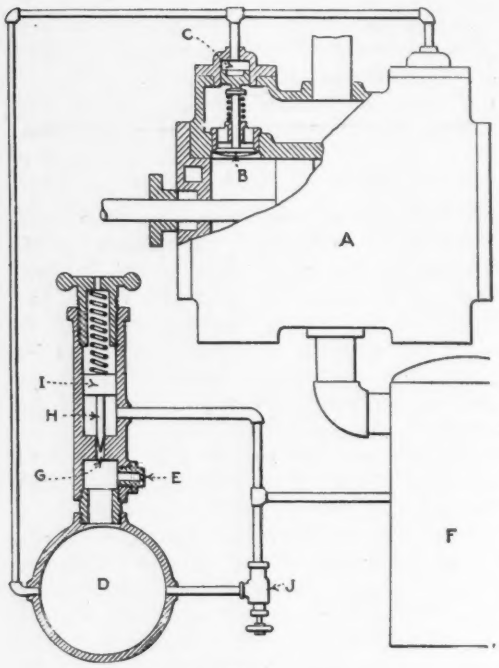


FIG. 2.

main tank, and the quantity of air entering the auxiliary tank, thereby decreasing or increasing the pressure in the auxiliary tank and changing the cut-off of the inlet valves so as to increase or decrease the amount of intake air until new conditions of equal supply and consumption of compressed air at the same pressure as before are established.

For a certain pressure in the auxiliary tank the air compressor will work at its maximum capacity, and the function of the adjustable needle valve is to admit constantly so much air as to produce this pressure. If more air be admitted the capacity of the compressor will be reduced, and the volume of the intake air will vary with the consumption only as long as the latter remains below this reduced capacity.

REGULATION BY ACTION OF THE DISCHARGE VALVES

Fig. 3 shows the application of the same principle to the regulation of the discharge valves of an aid compressor of the piston inlet type. The action of the device is similar to that represented in Fig. 2, and will be easily understood in referring to the drawing.

When the compressor is working at a constant partial load the air under pressure from the main tank will enter the chamber *K*, and counteract the tendency of the spring to force down the piston *I*. This piston carries the needle valve *H*, which closes to such an extent that the air enters the auxiliary tank *D* through the passage *G* at the same rate as it escapes through the leak *E*, thereby keeping the pressure in *D* constant. This pressure acts upon the cylinder valve *L* through the opening *M*. Under these conditions the pressure in the auxiliary chamber will be somewhat less than that in the main tank and in the passage *N* leading from the cylinder *O* to the main tank.

Owing to the low pressure thus created in the plunger *P*, the discharge valves will be kept open during part of the following stroke, and allow a certain amount of compressed air to re-enter the cylinder from the outlet passage *N* and expand in the cylinder to intake pressure. During the remaining part of the intake stroke the amount of fresh air drawn into the cylinder will exactly correspond to the consumption of compressed air at the time, and the air pressure in the main tank will remain constant.

Assuming now that the consumption of compressed air is increased a slight momentary drop of pressure in the main tank will result. The spring will overcome the effect of the

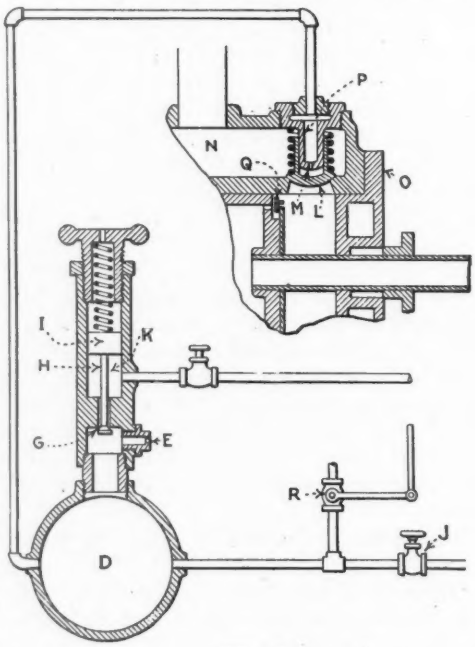


FIG. 3.

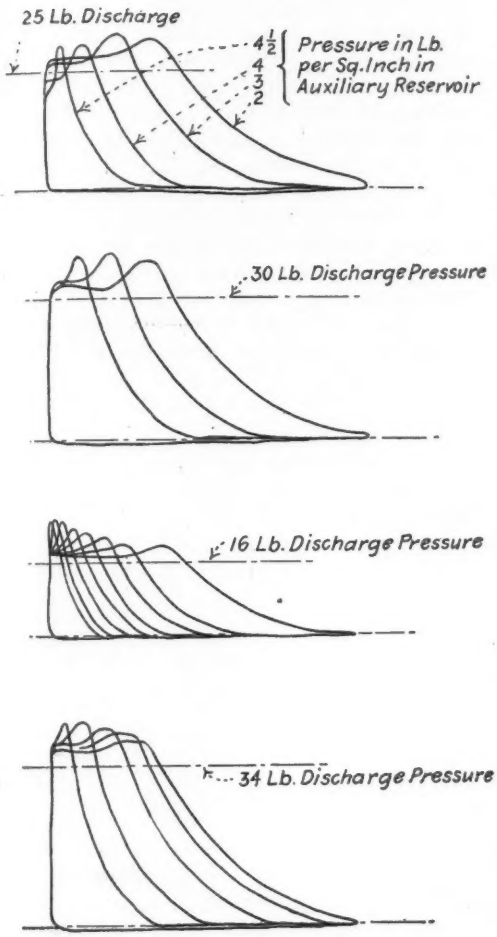


FIG. 4.

tank pressure on the piston *I* and will cause the valve *H* to open, thereby permitting a greater quantity of air from the main tank to enter the auxiliary chamber. The pressure in the auxiliary chamber will increase, and acting through the plunger *P* and the opening *M*, will cause the valve *L* to seat at an earlier point of the intake stroke, thereby increasing the volume of fresh air drawn into the compressor through the intake valve *Q* until it equals the increased consumption of compressed air taken from the main tank, the pressure in the tank being kept therefore exactly the same as before. In case of a decrease in the consumption, similar action will take place and a new equilibrium between supply and consumption will be established after a slight momentary increase of the tank pressure.

A needle valve *J* allows enough of the pressure air contained in the auxiliary tank to escape to the atmosphere, so as to unload the compressor by hand if desired. Valve *R* is opened by means of a speed regulator, if the speed of the prime mover falls below a certain value and it is desired to unload the compressor in that case.

For single or tandem compound steam driven compressors this device can easily be operated in connection with the ordinary speed and pressure governors, acting upon a throttle valve on the steam inlet, so as to regulate the output of the compressor between full capacity at its maximum speed and no volume at the lowest speed of the machine. On account of the perfect regulation which can be obtained by this combination it will in many cases be found advisable to use the cheaper single compressors instead of the duplex machines.

Fig. 4 shows a number of indicator cards taken on a standard *H* all poppet valve air compressor with by-pass equipped with the volume regulator shown in Fig. 2.

SALVAGE OPERATIONS ON THE EMPRESS OF IRELAND

In Compressed Air Magazine, Nov., 1914, page 7409, we gave an account of this interesting work. The following additional information comes to us through the *Scientific American*:

Probably no sunken wreck has presented a more difficult task for the salvors than this ship. Originally, the Canadian government employed a Canadian organization which made use of facilities developed by Mr. William Wallace Wotherspoon, the well-known salvage expert. The latter personally attended to the work, and was a potent factor in its success, although the fullest credit must be given to others, and acknowledgment must be made to the splendid services rendered by the British naval divers who assisted in the hazardous tasks of recovering the bodies of the dead as well as the mails and the silver bullion stored in the specie room.

At the particular point on the St. Lawrence where the "Empress of Ireland" went down the water is quite 138 feet deep to the surface of the soft mud bottom, and high tide

increases this by quite 14 feet. This means a very strong current, especially at ebb tide, and imposed a working period of but 30 minutes at each slack tide twice a day. Apart from that, the water was so cold that the divers' hands soon became numb, and to protect them it was necessary to employ rubber mitts. These were of American make and thin enough to enable the diver to guide himself by his sense of touch—something upon which he has to depend very largely in deep and dark waters.

After sinking, the "Empress of Ireland" partly righted herself, then heeled over at a very sharp angle, and settled deeply into the mud of the river bed. This added greatly to the perils of the work and made especially hazardous the operations incident to getting through the steel side of the craft and following a devious route into the ship's strongroom. These efforts required that the divers should work at the very unusual depth of 160 feet inside the body of the foundered liner, and, to make them familiar with their objective, they were previously schooled by means of a cardboard model of the internal structure along their route. Further, that their risks might be lessened, flanking doorways and one wide passage were bulkheaded off in order that the men should not go astray nor their hose, lifeline, or telephone connections become entangled.

The telephone played an important part in the operations. This telephone gear was of English design, but somewhat improved by American telephone engineering practices. Because of the dangers involved, the divers worked always in pairs; and as soon as one couple came to the surface two more men were immediately ready to carry on the work. One of the best things done was that of drilling into the side of the ship and cutting an ample passageway. The men worked upon a piecework basis, and they pushed ahead so rapidly that their rate was but little short of that ordinarily deemed excellent at a shipyard and in the open air.

The salvage craft was provided with a compressed air system, and the divers received their air from storage tanks instead of from pumps, as is the common custom, and there was also a hospital or decompression tank such as is used here in the United States in foundation work for skyscrapers. The diving was carried out agreeably to the practices prescribed by the British Admiralty, after certain well-known scientific tests, and while the unusual number of twelve divers were engaged upon the job only one man lost his life. He, unfortunately, slipped from the side of the sunken liner and dropped into much deeper water. The sudden application of hydrostatic pressure confused him, and in his excitement, instead of opening his air valve, he screwed it closed, and actually broke off the little hand disk! After that fatality every valve seat was notched so that air would reach a diver in distress and keep him alive until aid could be sent to him, no matter if he did jam the valve by mistake.

All of the bodies were recovered that could possibly be reached, and this was really the prime concern of the officials of the Canadian Pacific Railway; also the bullion and specie in the strong room were salved; and up to date substantially most of the mail pouches have been brought to the surface. In addition to this, the steel masts of the "Empress of Ireland," which were a menace to navigation, were cut away with air drills. This entire undertaking marks a notable advance in deep-water salvage operations, and shows that even the dangerous conditions on the St. Lawrence will not daunt determined men when guided by thoroughly competent experts.

CEMENT A PROTECTION AGAINST SAND BLASTS

The use of cement as an anti-sand blast is possibly one that is little known. The sand blast in question, however, is not that which is so familiar to all of us, but is quite of another type. When locomotives stand under steel or iron bridges or viaducts, the blast from the stacks throws out gases and numerous small particles of ashes and coal. This when continuously projected against the overhead iron or steel gradually causes its disintegration. "When all remedies fail, try cement," and in this case cement was tried and not found wanting and now it is common practice for railroads to cover the bottoms of their bridges with wire netting or metal lath covered with a coating of sand and cement which it has been found resists perfectly the attack of the gases and also the sand blast coming from the locomotives.

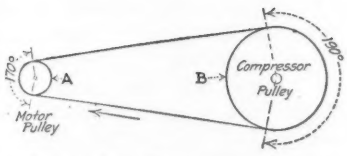


FIG. 1. LONG BELT WITHOUT IDLER

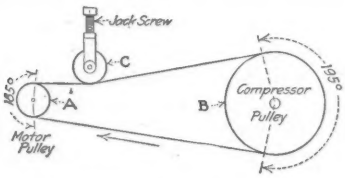


FIG. 2. FIXED IDLER

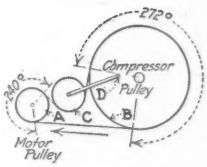


FIG. 3. SHORT BELT

THE SHORT BELT DRIVE

In a recent issue of *Power* Mr. W. F. Schaphorst treated of certain idlers on belt drives as though they were something new, but in fact compressor builders have long used them.

To test their efficacy, the Ingersoll-Rand Co. equipped a machine in its power house, some four years ago, and their performance was closely observed for about a year. As a result they have been adopted as standard design under the name of the "Short-Belt Electric." The compressor builder sought this means in order to solve the limited-floor-space problem, but this is not considered the only advantage, as the illustrations will show.

Fig. 1 is the ordinary belt drive, in which the distance between centers of pulleys must be sufficient to give a reasonable arc of belt contact on the motor pulley, which at best never exceeds 170 deg.

Fig. 2 is sometimes resorted to when Fig. 1 fails to work satisfactorily. A tightener pulley *C* is placed between the pulleys *A* and *B* and held firmly against the belt. This increases the arc of contact on the motor pulley to 185 or 190 deg., but it also increases the belt tension, which is undesirable.

Figs. 3 and 4 show the short belt drive. This consists of the driving pulley *A*, the driven pulley *B*, and an idler pulley *C*, which is placed on the slack side of the belt close to the driving pulley. The idler pulley is carried on arms swung from the compressor frame and is free to rise and fall, or to float on the belt.

While the idler pulley is light, its weight is sufficient to take up the slack and hold the belt against the driving pulley. When the tension on the tight side of the belt increases and lengthens the slack side of the belt, the idler pulley immediately descends, taking up the slack and at the same time wrapping the belt further around the driving pulley and giving a greater arc of contact. The belt contact is increased rather than the tension.

Most belt-transmission losses come from slippage or from excessive tension. With the short-belt drive there is no initial belt tension and but little slippage. When the motor is stopped the belt has no strain, and only the strain of the effect while in motion.

It will be seen from the foregoing that this form of drive has long passed the experimental stage.

CHARLES A. HIRSHBERG.

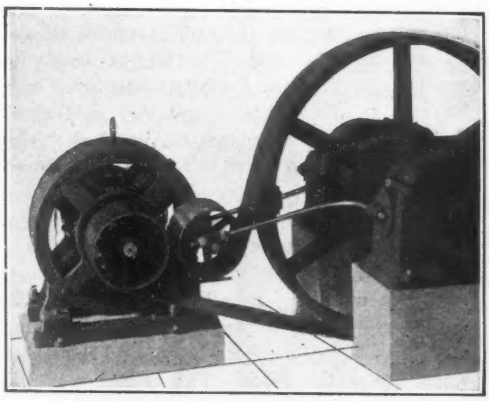


FIG. 4.

AMATEUR TUNNELING

Detectives recently discovered a number of underground passages near the belt line in Newberg, Ohio, which have been used for transferring coal from cars on the tracks to the basements of nearby houses. The passages had openings in the back yards abutting on the tracks, and these were covered by trap doors upon which piles of rubbish were usually kept to hide them. The other ends of the tunnels opened into the basements of the houses. Coal would be thrown from the cars into these back-yard openings and then would be carried through the tunnels into the basements. It is said that an entire carload of coal disappeared one night recently.

ECONOMY OF BLOCK HOLING

The tests described below, carried on by the Bureau of Mines, should interest contractors and others who have a considerable amount of boulder-breaking to do. The tests were made to determine the comparative energy expended by explosives under water and in the air, and by various methods of shooting.

The test showed very conclusively that the block-hole method of breaking boulders and large fragments of rock is very much superior to and more economical than the mud-cap or adobeshot method of breaking, which is so commonly practiced.

"Adobe shots" were made on two high-grade limstone blocks cut from the same large block and weighing 215 and 203 pounds. Each block was approximately a cube, measuring 12½ by 12½ by 13 inches. The heavier block was selected for tests in the air. It was laid on two 6 by 6-inch timbers, and on the center of the top side a 50-gram 1¼-inch cartridge of the 40 per cent. strength low-freezing dynamite was placed. A No. 6 electric detonator was inserted in the cartridge and laid parallel to the vertical bedding planes of the block. The charge was then covered with a 35-pound mud cap consisting of 30 pounds of dry fire clay mixed with 5 pounds of water and fired. The block was not shattered on top, but pieces were split off around the sides. The other block was then immersed in a barrel of water having a temperature of 70 degrees F. The water was 32 inches deep, there being 13¼ inches of water above the block. The charge was the same as in the previous trial except that no mud cap was used, and the charge was coated with paraffin in order to protect it from absorbing water. On firing no apparent damage was done to the block and no cracks were visible. This trial was then repeated on the same block immersed in water with a charge of 100 grams. This greater charge did not break up the block as much as did the 50-gram charge when the block was in air only.

Other similar tests confirming in every particular these tests, and again the confining effect of the surrounding material was shown. The above experimental proof is presented as a confirmation of practical experience that submarine blasting requires larger charges to disrupt a given amount of material than open work on similar materials.

Block-hole tests were made on two similar high-grade limestone blocks cut from the same large block and weighing 198 and 205 pounds. A hole 1 inch in diameter and 6 inches deep was drilled from the center of one side to the center of the block. Each was charged with 5 grams of the 40 per cent. strength low-freezing dynamite. A No. 6 electric detonator was used. The bore hole was filled with water in each case. The 198-pound block was fired in air and the 205-pound block was suspended in a barrel of water in the same manner as in the previous tests. Both blocks were broken. The following tabulation shows comparative results:

It will be noticed from these figures that

COMPARATIVE RESULTS OF ADOBE SHOTS ON LIMESTONE BLOCKS

Condition of Block	Quantity of Explosive used	Weight of Block	Weight of Largest Piece	Number of Pieces over 3" in Diameter	Average Weight of these Pieces	Total Weight of small Pieces
	Grams	Pounds	Pounds		Pounds	Pounds
In air	50	215	82	13	15.5	11
In water	*100	203	104	8	24.6	5

*After firing a 50-gram charge.

COMPARATIVE RESULTS OF BLOCK-HOLE TESTS WITH LIMESTONE BLOCKS

	Grams	Pounds	Pounds		Pounds	Pounds
In air	5	198	52	15	12.7	7
In water	5	205	59	11	18.2	5

the quantity of explosive used when a block hole had been drilled into the rock fragment was from one-tenth to one-twentieth as large as that required by the mud-cap or adobe-shot method.

CAPE-TO-CAIRO RAILWAY

Six thousand miles, across sixty-five degrees of latitude; a score of climates and the lands of a hundred different peoples or tribes; the second longest of the world's rivers and two of its largest lakes; the greatest dam ever built, conserving water for the world's richest lands; the most imposing and ancient of all temples; the greatest waterfall, and the most important gold and diamond mines; and finally, one of the last great expanses of real wilderness, the only place in the world where the wild beasts of the jungle may be seen in their primitive state from a train, all these seen, traversed, or experienced in twelve days! Surely, there can never be another such railway as this.—*Lewis R. Freeman, in The World's Work.*

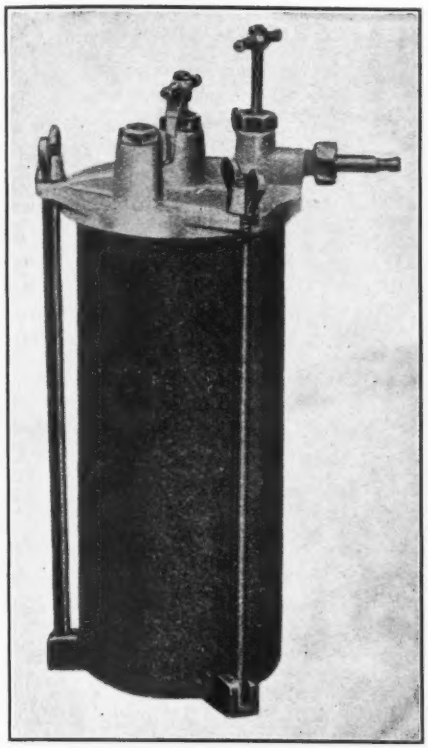


FIG. I.

A NEW ACETYLENE GENERATOR

A new type of acetylene generator which is being introduced in England by the British Low Accessories Company, Limited, is described in a recent issue of *The Engineer*. It is primarily intended for the lighting of motor cars, but there appears to be no reason why it should not be made serviceable in other directions. The makers, in referring to this generator, explain that the success which followed the introduction of electric lighting equipments has been largely due to the facility which it affords of being able to turn the lights on at a moment's notice. This, it is pointed out, is the one outstanding advantage which can be urged in favor of electricity, and, as against it may be put the considerably heavier cost of the electric equipment as compared with that of an acetylene outfit, which may be as much as many times as great.

The first step which was taken by acetylene lighting apparatus manufacturers in order to put such apparatus more on a level with electric lighting in this respect, was the employment of dissolved acetylene cylinders. By the use of these gas was always obtainable by the simple turning on of a tap. This course, however, had the disadvantage of considerable expense, and suffered from the fact that the cylinders could not be recharged at home. It was found that, however easy it might be to get spares, there always came a time when the cylinder gave out. It is to remedy this state of affairs that the new generator has been devised.

The engraving—Fig. 1—shows the new Low generator complete, and Fig. 2 shows it in part section. It may be said at first that it is not only a generator but a storage reservoir as well. The apparatus will be readily understood from the drawing. In this A is a steel drum with an open top, which is closed by a cover B, which is held on tightly by means of three screw clips, the joint being made gastight by packing C—see Fig. 1. The inside of the cylinder is coated with a substance D, which is capable of occluding or dissolving acetylene gas. This substance is, we understand, a mixture of acetone, asbestos, porous brick, and plaster of Paris. Resting

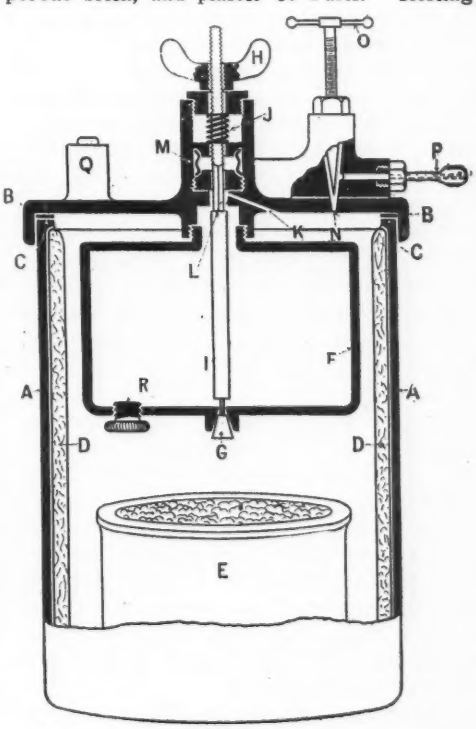


FIG. 2.

on the bottom of the steel drum is a cylinder E, for containing calcium carbide. On to this an adjustable quantity of water from the tank F can be made to drip through the valve G. This valve G is regulated by the wing nut H, acting on a screw on the spindle I, and the spring J always tends to keep it open. A gas passage K leads through the cover C to the passage through which the spindle I passes through the lid B, at which point the spindle is square, so that the gas can pass it and reach the interior of a bellows arrangement M. By this means, when the pressure of the gas in the cylinder A rises above a certain predetermined point, the bellows M expand, the spring J overcome, the spindle I raised, and the valve G closed, so that no more water can drip on to the carbide. When, on the other hand, the pressure falls, the bellows close, and the spring J again asserts itself so that the valve is opened. In this way the apparatus is automatic. It will be realized also that the gas is generated actually in the presence of the substance which occludes or dissolves it, so that even when all the carbide is used up there still remains a good deal of gas which can be drawn upon.

The outlet of the gas is at N, and this outlet is controlled by a pin valve, which is operated by the handle O working a threaded spindle. This valve allows the gas to find its way to the connecting piece P. Should the pressure, either when the pin valve is opened or closed, rise above a certain point, which depends, of course, on the strength of the various parts of the apparatus, the safety valve Q comes into operation and the surplus gas escapes to the air. It will be understood, of course, that as the pressure rises more and more gas is occluded in the dissolving material.

The generator is readily cleaned and recharged. All that is necessary is to remove the cover B by unscrewing the three wing nuts, take out the outside tin, empty clean and recharge it, sluice out the cylinder A if necessary, replace the tin E and refix the cover. It is not necessary, in order to replenish the water reservoir F, to remove it from the cap C, to which it is screwed, for water can be placed into it by turning it upside down and removing the plug P.

A number of claims are made for this apparatus, among which may be mentioned the following: (1) The gas, being dissolved, comes out dry and clean, thus ensuring a good combustion and pure light; (2) the gas being permanently stored under pressure, is delivered as soon as the cock is opened, so that lamps can be lit up immediately, and long before the stored or dissolved gas is used up fresh gas is being generated from the carbide to keep up the pressure; (3) as soon as the cocks are shut nothing can waste; the gas can be stored for years without deterioration, and will always be available at any time during that period; (4) there is no chance of explosion, and a light can be held in safety all around the generator itself; and (5) that nothing can get out of order.

ABOUT SUBMARINE MINES

A floating mine is not intended to drift about, but is put down with an automatic mooring apparatus, so that the limits of an area strewn with mines may be fairly definitely known once the sowing has been discovered. Occasionally a mine breaks loose and drifts about, but this is not the intention of the mine planters. Mines do not float in sight, but are moored to keep at a certain level below the surface. It is also intended that they should strike the most vulnerable parts of war vessels, therefore they are placed deep enough to miss the armored belts of such. The average size of mines is from four to five feet in diameter and they are charged with high explosives. The idea that a mine explodes through the force of a ship striking it is erroneous; tilting it from an upright position explodes it.

The operation of sweeping for mines is carried out by two ships steaming parallel with one another at some distance apart with a wire rope between them, sunk low enough to come in contact with the cables to which the mines are moored, which has the effect of tilting them over and causing them to explode. The danger of this operation is in the possibility of the ships themselves coming in contact with a mine, but there is no danger from the explosions of the mines by sweeping. Even a distance of 100 yards from a mine when it is exploded secures perfect safety to any vessel, as the cushion of water takes up the shock. Very light draft vessels are always chosen for this work, so that they have a good chance of passing over mines sunk deep enough to damage ships of war.—*Marine Journal.*

FIG. I. TAMPERS AT WORK.

PNEUMATIC TAMPING OF RAILROAD TIES

Compressed air is being used successfully for tamping ties on a part of the New York Central & Hudson River Railroad. The tamping outfit consists of two pneumatic tampers, 600 ft. of ¾-in. hose and an air compressor mounted on a hand car. The compressor is driven by a gasoline engine, which also propels the car itself at a speed of from 12 to 15 mi. per hour. The car will carry twelve men and is equipped, as one of the illustrations shows, with cross trucks, with the aid of which four men can remove the car from the track in less than a minute.

One of the illustrations shows the two tampers in use, with one man for each. Each tamper is fitted with a tamping bar of the ordinary shape, and weighs, complete, 37½ lbs. It is stated that the machine is equally effective for stone, gravel or cinder ballast, that it can be worked to advantage around frogs and switches where hand tamping is difficult or impossible, and that trackmen prefer it to the tamping pick or the tamping bar. A performance record kept on one of the units through the entire season of 1913 showed a tamping cost of 2.6 cents per tie with the machine, as compared with from 10 to 20 cents by the hand method. The record also showed that two men can average 300 ties per day.

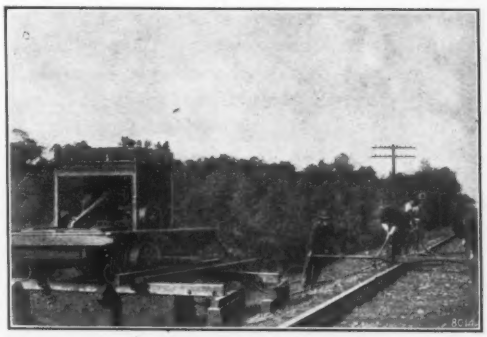


FIG. 2. SHOWING COMPRESSOR CAR.

A service test was made some time ago to determine the comparative stability of track tamped by hand and that tamped pneumatically. A section of track on the West Shore Railroad in the Hackensack Meadows in New Jersey was selected, where the foundation is soft and it is difficult to maintain the track in good condition. An 800-ft, stretch of track was tamped by machine and an equal length by hand. After six months observations showed settlement as given in the accompanying table.

TRACK SETTLEMENT IN INCHES AFTER HAND AND MACHINE TAMPING.

	Greatest.	Least.	Avg.
Hand tamping	0.116	0.018	0.067
Machine tamping ...	0.063	0.004	0.033

The compressor cars and pneumatic tampers are manufactured by the Ingersoll-Rand Company, of New York City. The New York Central & Hudson River Railroad now has twelve outfits in service.

EFFICIENCY IN MICHIGAN COPPER MINES

Unlike the Lake Superior iron mines, where "efficiency engineering" has received only fitful encouragement, the Lake Superior copper mines have given it careful and systematic attention for several years. In fact, the zeal of the copper companies for efficiency engineering became possibly a little too absorbing; for it is no secret that it was one of the indirect reasons for the long and costly Lake Superior strike. Two or three years ago, it was rumored around Lake Superior that the new efficiency campaign in progress with the Calumet & Hecla companies would save them half a million dollars or more per year. The cost of driving had been reduced 30 to 40

per cent. and the cost of stoping 10 to 20 per cent. At the same time, apart from the attitude of the miners who did not take kindly to the efficiency methods, the thorough tabulation of rock drilling and mining methods brought to light by the campaign were interesting. An outsider would be surprised at the detail with which the art of rock drilling was studied. For instance, the operation of cranking back a rock-drill on its feed-screw, performed three or four times for every hole drilled, was found to take a certain number of seconds under ordinary conditions. But when the crank handle was fitted with an iron ring or flywheel (like that on a large ice cream freezer), 8 or 10 inches in diameter, it was found that cranking back took several seconds less each time. With such a flywheel, given a few swift turns, a well greased rock-drill would nearly screw itself back. In a small mine such a detail would, of course, not be worth bothering about, but with several thousand men of the Calumet & Hecla companies, it was considered worth while. In the experiments using compressed air of different pressures for running rock-drills, it did not always make a drill operate faster or hit harder to increase the air pressure. For instance, one drill of certain make and with a certain kind of valve, drilled faster with air at 70 lb. pressure than with air at 85 lb. Other rock-drills required the high pressures for best working. One drill could not stand too much air at once, and worked best with the air inlet cut down to ½ in. Water in the compressed air affected some rock-drill valves badly, and made them freeze; another type rarely froze. Rock-drills with a "short-stroking" attachment were desired, not only for convenience in "fitchered" holes, but for using drill-steels slightly too long for the full stroke, as often happens in changing steel, and for general desirability in starting holes. The attention given to setting up a column with its swinging arm and saddle, was also very close and several small mechanical appliances were invented to hasten that part of the miner's work. Another feature adopted by some companies is the use of ⅞-in. drill steel in place of 1⅛-in., which reduces the area of the drill holes so that with less rock to cut, the cutting goes faster, requiring, however, higher per cent. dynamite in narrower sticks. On the South Range, where the Copper Range Con. mines use the "dry-wall" method of stoping (the lodes are too flat for it as Calumet), tailing from the stamp-mill is brought back in the ore cars and piped and blown by compressed air into the stopes for standing on to reach the back, in this way eking out the waste rock ordinarily used to stand on as a result of the sorting underground. It was formerly necessary to tap old stopes for additional waste or to blast it from the walls, which methods were expensive, especially the latter.

In 1909, when two-man drills were in use, the average driving per man per shift was 0.7 ft. for the Superior mine (as well as approximately for the entire copper country). In 1911, when the Calumet & Hecla had introduced one-man drills and efficiency methods in its Superior mine, where these innovations were first given trial, that mine raised this figure to 1.2 ft. per man per shift, and a little later to 1.5. Since then all the Calumet & Hecla companies have introduced the methods tried out in the Superior, as have most of the other operators also, and nearly as startling gains in efficiency have been made as was the case in the Superior.—*Mining and Scientific Press.*

IMPORTANT PATENT SUSTAINED

In the construction of the foundations of many of the great buildings of more recent erection in lower Manhattan, caissons have been sunk close together, all around the space built upon, and these caissons have finally been so joined together as to form a watertight enclosure. A patent embodying this system was issued to John F. O'Rourke, July 16, 1901, and this patent has been sustained in a decision by Judge Learned Hand, Dec. 31.

The O'Rourke Engineering Construction Co., brought suit against The Foundation Co., for infringement of the above patent. The defendants claimed that the construction described in O'Rourke's patent was anticipated by the method of construction adopted in the foundations of the Postal Telegraph building, on the corner of Broadway and Murray St., New York City. Apparently in this building independent caissons were sunk, but the methods adopted for closing the space between them differed from that set forth in the O'Rourke patent, and the judge held therefore that the latter was not anticipated.

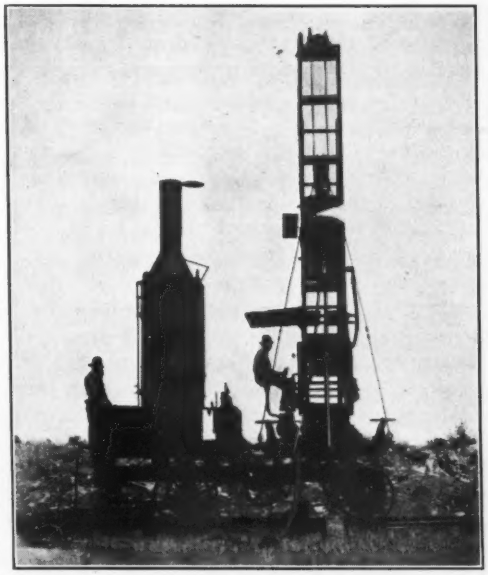
DRILL WAGONS IN QUARRY WORK

At the quarry of the Dewey Portland Cement Co., Dewey, Okla., the one thing to be accomplished is the getting out of the material in condition suitable for the crushers and at as low a cost as possible for the operation. The surface of the rock is practically level and the general scheme is to drill holes to a uniform depth and about 10 ft. apart, loading them with 3 in. 40 per cent. gelative and firing a large area at once, the object being to raise the rock and break it up, and not to throw it out into the quarry, the subsequent handling of the rock being done by a steam shovel.

During the present year the drilling has all been done by one drill wagon equipment. This comprised a standard Ingersoll-Rand H-64, 20 ft. feed, turntable drill equipped with a 35 hp. boiler. Ordinarily the machine is operated by one drill runner and one helper, and when necessary to move the track additional help is called up from the steam shovel and switching gang in the quarry. It is considered, however, that there should be three men constantly attached to the drill to run it most efficiently, as even though the boiler is gas fired, it requires considerable attention to keep the steam right, and the one helper can hardly find time to keep things going all right at each end of the wagon.

When demonstrated for acceptance this drill did from 140 ft. to 200 ft. of 3¼ in. hole per 10 hr. day, the holes being from 18 to 20 ft. deep. The drill was sold under a 150 ft. guarantee, which was easily made to the satisfaction of the quarry owners, and no attempt was made by the demonstrator to make or break any records, most of his time being spent in teaching the new operator how to get the best results. Another reason for not attempting any astonishing records in this case was in the fact that there was great objection to the water used in washing the cuttings out of the hole, as the rock mixed with this water becomes more or less muddy and does not go through the crusher as well, so that it was necessary to reduce the supply of water to a minimum and then the drill throttle could not be opened to take full advantage of the power available. Under other conditions the drill would not be under this handicap, and could make a still better showing.

At each setting of the wagon on the track one hole would be drilled on the side, with the drill in the position shown in the photo, Fig. 1, and then the turntable would be given half a turn for drilling a corresponding hole on the other side of the track; after moving the machine along 10 ft. on the track two more holes would be drilled in the same way, and so on.



DRILL WAGON IN QUARRY.

THE SAND BLAST FROM THE USER'S VEIW-POINT

BY H. D. GATES.*

The foundry sand-blast was developed for the cleaning of castings, and its many advantages for cleaning or surfacing in all branches of metal working, plating and finishing have been so fully demonstrated that it is today a fixture. Thoroughly sand-blasted castings can be machined more rapidly and at reduced expense. The value of the sand-blast in sheet and structural steel work has been thoroughly demonstrated, and the railroads generally demand the sand-blasting of steel cars before painting. A smooth surface results and the paint protects the metal better from corrosion. Metals to be plated, japanned, galvanized, sherardized, or treated with the various rust prevention processes, such as "Coslettizing," "Bower-Barff," "carbonium,"

*Abstract of paper before Associated Foundry Foreman of New York.

etc., are thoroughly cleaned by the sand-blast preparatory to treatment. Bars, rods and plates to be electrically welded are freed from scale and rust in order to insure perfect contact.

A variety of sand-blast apparatus is available for foundry-men and other users; for small work adapted in size and shape for cleaning in the sand-blast barrel there can be no question of the economy of this type of machine. Pieces too large for successful barreling may be cleaned with the least labor on the round and reciprocating type table machines, but if the pieces are of such shape or design as to demand constant turning to bring all surfaces under the action of the nozzle, one of the small enclosed cabinets of the self-contained continuous feed type, with stationary or portable nozzle, may be found more efficient. The combination pressure blast and cabinet machine also affords at small cost efficient equipment for a small volume of work of varied character. It is safe to say, however, that the varied character and limited output of the majority of foundries and other plants requiring sand blasting equipment is best served by machines that will clean everything and anything. For these the hose type machine is most efficient. It is simple, having few working parts, and the up-keep cost is reduced to a minimum.

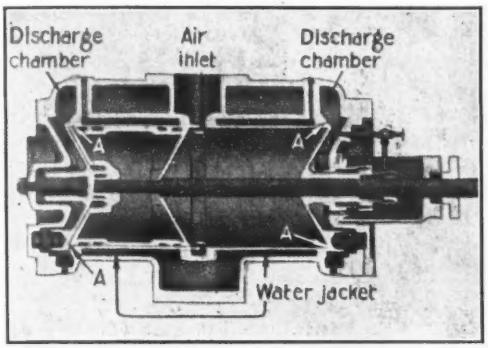
Under pressure of 80 pounds per square inch a 3-16 inch nozzle will discharge 48 cubic feet of free air per minute and 500 pounds of sand per hour; a ¼ inch nozzle discharges 85 cubic feet of air per minute and approximately 900 pounds of sand per hour; a 5-16 inch nozzle, 133 cubic feet of air per minute and 1300 pounds of sand per hour; a ⅜ inch nozzle, 191 cubic feet of air per minute and 1700 pounds of sand per hour; a ½ inch nozzle, 340 cubic feet of air per minute and approximately 3000 pounds of sand per hour.

What is the most satisfactory working pressure is a question much discussed, but to which there is but one answer, and that is the pressure at which the work can be done the cheapest, all other factors being considered. If it is required to remove loose sand from castings a working pressure of 30 pounds or less will undoubtedly be satisfactory even on iron or steel, and should provide a surface suitable for painting. If, however, the castings are to be machined, every particle of the fused sand should be taken off in order to expose the clean metal to the action of the cutting tool. This condition on steel can be secured only with sand-blast pressure up to 90 pounds in order to be economical. Removing all the fused sand will not only reduce tool expense materially, but in actual practice has demonstrated that the output of machine tools will be increased at least 15 per cent.

In order to determine the most economical pressure for sand-blasting apparatus there must be taken into consideration, besides the elements of labor and abrasive, the initial pressure at which the air is being delivered from the compressor. The majority of pneumatic equipment in use today requires about 80 pounds pressure, and in some installations of sand-blast apparatus we find the air supply is being delivered to the receiver at this pressure. While it might be demonstrated that the castings could be most economically cleaned at a lower pressure if the air were initially compressed to that pressure, it is manifestly cheaper to use the air at the full or standard pressure of 80 pounds if other requirements in the plant demand that pressure. The fact must not be lost sight of that every cubic foot of air used for sand-blast purposes which is reduced to the lower pressure costs the same in horsepower expenditure that it would if it were used at the initial pressure of 80 pounds.

Tests made by Prof. William T. Magruder, reported in a paper read before the American Society of Mechanical Engineers, to determine the amount of metal removed by a sand-blast showed that the time required to remove one pound of iron with 20 pounds pressure was 3.55 hours; 30 pounds, 2.77 hours; 40 pounds, 2.13 hours; 50 pounds, 1.52 hours; 60 pounds, 1.07 hour; and 70 pounds, 0.82 hours. In one instance it was shown that 230 cubic feet of free air requiring 73 horsepower to compress, was discharged through a 9-16 inch nozzle at 40 pounds pressure, and 120 pieces weighing 200 pounds each were cleaned in a ten-hour day. With a pressure of 80 pounds passing through a ½ inch nozzle, flowing 140 cubic feet of free air per minute, 156 pieces were cleaned in ten hours. In the first instance the air was compressed to 80 pounds and passed through a reducing valve to the sand-blast machine. Had the air in the first instance been initially compressed to 40 pounds the power saving would have been over 12 per

cent. of the higher pressure to say nothing of the greater output. The general proposition of the low pressure cleaning is volume of sand, which requires the large hose and nozzle, consuming air at low pressure and cost, while the high pressure provides a minimum of sand driven with high velocity through a small hose and nozzle with high pressure and cost of air. The horse-power cost is approximately the same for the same results by either operation with the air initially compressed to the operating pressure, and the determining factors will therefore be the volume of output with a minimum of labor cost.



AIR PUMP WITHOUT CLEARANCE.

AN AIR PUMP WITH NO CLEARANCE.

An air pump, invented by E. W. Christie, mechanical engineer of the Wheeler Condenser & Engineering Co., at Carteret, N. J., solves the question of clearance by using a central belt port (like the Unaflow engine's exhaust) for an inlet port and making the cylinder head the exhaust valve.

Referring to the accompanying section, when the piston is at the end of its stroke the central port is uncovered and the cylinder fills with air and vapor of the pressure existing in the condenser, together with some water. The first movement of the piston on the return stroke covers this port and the air and vapor are compressed and, with the water, discharged at *AA* when the head which forms a discharge valve is lifted from its seat against the tension of the seating springs. The movable heads are made to fit closely into the piston so that the clearance is eliminated.

The cylinder barrel is completely water-jacketed except at the air-inlet ports. The pump is of the "wet air" type, removing both air and condensate, but may be used for air only by furnishing a slight amount of sealing water. It is adapted to either the crank-and-flywheel construction or for connection to direct-acting steam cylinders, with which, regardless of the variable stroke, the air is completely discharged and a high vacuum is thereby maintained. The combined equipment—direct-acting air and condensate pump at one end, steam cylinder in the center and direct-acting circulating pump at the other end—usually good for 25 to 26 in. of vacuum—will, with the Christie pump, maintain a vacuum of 28 in. or more. In tests at the shop, guaranteed performances of 28 in. with 80-deg. water are easily surpassed. A higher vacuum result was as follows:

Barometer	30.2 in
Vacuum attained	29.4 in.
Pressure in condenser (abs.)	0.8 in.
Temperature sealing water	60.0 deg. F.
Pressure corresponding to 60 deg. F	0.522
Pressure in excess of that of vapor	0.278

The pressure in the condenser was less than 0.3 of an inch more than the vapor tension due to the temperature of the sealing water, showing that the pump maintains a vacuum nearly the theoretical maximum.—*Power.*

FALLING BODIES IN DEEP MINE SHAFTS

The Michigan College of Mines, Houghton, Mich., has made some tests of falling bodies in a deep vertical shaft of a copper mine at Calumet, Mich. Within a radius of a mile from Calumet are three of the deepest shafts in the world, one of them being 5,300 ft. deep. One of the experiments consisted in dropping a smooth metal ball 2 in. in diameter from the centre of the shaft and trying to catch it in a box of clay placed 4,200 ft. beneath. Another ball was dropped from the south-west corner of the shaft. The balls were dropped by burning threads by which they were suspended so that they started to fall without any lateral motion. The shaft is 9 ft. by 30 ft. in cross-section. The first of the balls was suspended 4 ft. from the side of the shaft and the second from a point 9 ft. from the opposite corner. Neither of the balls reached the box of clay; one of them was never found and the other, presumably the one started from the

centre, was found by a workman lodged in the timbers on the east side of the shaft 800 ft from the surface.

Bodies dropped into the shaft invariably lodge somewhere in the east wall. This action takes place because the earth is rotating on its axis from west to east. At Calumet a particle at the surface is moving to the east at the rate of about 1,000 ft. per second; but a particle 5,000 ft. down the shaft, having the same angular velocity as the particle on the surface, is moving eastward at a rate of 4 in. less than 1,000 ft. per second. The ball suspended at the top of the shaft had a 1,000-ft.-per-second velocity; it was not only moving eastward at that rate when it started to fall, but continued moving eastward all the way down the shaft. Meanwhile, it dropped to the bottom at a rate which would have taken 17¼ seconds for the fall, if there had been no air resistance to encounter. During the 17½ seconds, the particle at the surface and the ball falling at the same rate would have travelled 17½ times 4 in., or nearly 6 ft. further eastward than the particle at the bottom of the shaft. The ball started from the centre of the shaft, therefore, struck the east wall long before it reached the bottom. As a matter of fact, the resistance of the air at the high speed the ball acquired soon after starting, was sufficient to prevent any further acceleration, and consequently the ball was much longer than 17½ seconds in falling. In fact, only 800 ft. of fall was required for the ball to make the 4 ft. from the centre of the shaft to the east wall and the other ball must have lodged at some point not much further down.

If the walls of the shaft were smooth and free from obstruction, no doubt a falling body would rebound from side to side of the shaft and finally reach bottom, but the many timbers in the lining of the shaft and the levels all the way down furnish places where a body is sure to lodge, and so if a load of ore were to be spilled into the shaft near the top most of it would later be found clinging to the shaft or stranded on the levels east of the shaft.

Buoys of reinforced concrete built for Kingston, Jamaica, weigh each about 5 tons, carry about one ton of ballast, and are said to cost a little less than half as much as steel buoys of the same size.

MACHINE COAL-MINING

According to returns made by the United States Bureau of Mines, the use of coal-cutting machinery is rapidly advancing. In the year 1900, about 20 per cent of the output was won in this way, whereas in 1913 the proportion had risen to 46 per cent. In Great Britain the advance had also been notable, but is still far behind that of the United States, for in 1913 only 9 per cent. of the output was won by machines. The following tables give the number of machines in use, the amount of coal won by machines, and the output per machine during the last few years.

UNITED KINGDOM.

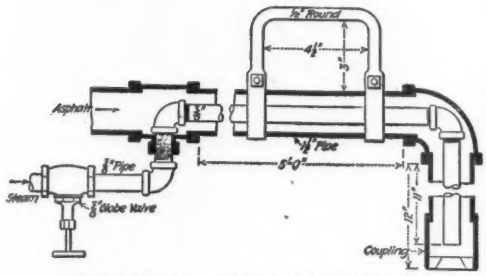
Years.	Machines in use.	Coal won.	Production per Machine.
	No.	Tons.	Tons.
1900	311	3,312;000	10,650
1902	478	4,161,200	8,706
1905	946	8,102,200	8,564
1906	1,136	10,202,500	8,981
1910	1,959	15,878,800	8,105
1911	2,146	18,667,300	8,698
1912	2,444	20,274,100	8,295
1913	2,894	24,609,300	8,503

UNITED STATES.

Year.	Machines in use.	Coal won.	Production per Machine.
	No.	Tons.	Tons.
1900	3,907	47,129,000	12,062
1902	5,418	62,153,300	11,471
1905	9,184	92,318,200	10,052
1906	10,212	106,113,800	10,390
1910	13,254	155,368,100	11,722
1911	13,829	159,070,000	11,503
1912	15,298	187,981,100	12,280
1913	16.381	216,496,900	13,216

During the same time, the total United States production advanced from 240,800,000 tons in 1900, to 509,000,000 tons in 1913, and the British production from 225,000,000 tons to 287,000,000 tons. Of the various types of machine, there were in 1913 in Great Britain, 1246 disc, 542 bar, 250 chain, 839 percussive, and 17 rotary heading machines. In the United States the classification was: 6327 pick, 6936 chain-breast, 791 longwall, 2210 shortwall, and 117 radialax or post machines.

An average day's work for a fireman on a large locomotive is to handle 25 tons of coal at the rate of about five 15-lb. shovelfuls per minute of a 10-hr. day



SPRAYING HEAVY ASPHALT

The accompanying illustration shows the details of a spraying nozzle used on all the asphalt distributing wagons of the Illinois State Highway Department. Steam and compressed air are supplied by a steam road roller or traction engine, used to draw the asphalt tank wagon. The nozzle is attached to the tank wagon by a flexible hose connection and the hot liquid asphalt is forced out under air pressure in the usual way. This type of nozzle is suitable for all grades of asphalts or tars. It has been found to be very satisfactory in surface-oiling roads, as the material can be applied in a very fine mist in any quantity desired from ⅛ gal. to 2 gal. per sq. yd. The steam connection near the base of the spray superheats the bituminous material and also breaks it up into a very fine spray as it comes from the nozzle under the air pressure. There are other advantages in this type of nozzle, inasmuch as the high pressure that can be secured will remove surplus dust from the surface of the road and also force the bituminous material into all interstices of the road surface.—(P. C. McArdle, Acting Chief Engineer, Illinois State Highway Department.—*Eng. News.*)

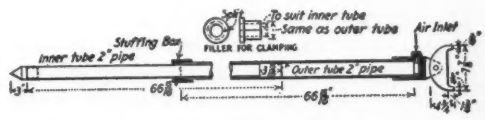
PNEUMATIC DRILL COLUMN

BY SVEN V. BERGH.

An important factor to be considered in getting the highest efficiency out of the modern hammer-drill is the simplification of the drill mounting when such mounting is required. The labor cost, compared with the other costs of operation, is in most cases predominant, and it must be borne in mind that, roughly estimated, only 40 to 50 per cent. of the total shift can be used for actual drilling, the rest being absorbed in setting up and other manipulation of the machine.

When a column or bar has to be used the drill may be either attached to it directly or it may be carried on an arm; the column itself may be either the single-screw or the double-screw type. In any case, its height is adjustable to only a limited extent. Hence, to make a set-up in the best position for the round of holes to be drilled, the workman has to use a good deal of skill and do considerable planning; in most cases a lot of time is wasted in mucking, arranging blocking, picking down back or picking up bottom, in order to get good bearing surfaces for the column.

To facilitate these operations, a pneumatic drill-column was devised and has been used with good results for several years at the iron mines of Malmberget, Sweden. It resembles in general the telescopic air-feed of the stoper type of drill. A longitudinal section is shown herewith. The height of this particular column can be varied between 6.23



and 11.48 ft. When the column is fully run out, the compressed air is shut off by means of an automatic cutoff valve. There is no need of the usual arm in order to provide a sufficiently wide range of positions for the machine. The column, drill and all are easily removed from one position to another as required, and the absence of an arm makes this all the easier. The drill-clamp is adjustable with one single screw-bolt, and is made with a hinge so that the machine can be swung over to one side, when the drill steel has to be changed. The clamp is attached to the outer tube. This has a toothed foot-piece which bears on the bottom and resists rotation. The inner tube ends in a point which bears against the back. It is, of course, not subject to any torsion.

The column was found sufficiently stable when the regular drilling pressure was used, but is adapted only to light hammer drills of the stoper type with telescopic air feed and for drilling in soft to medium-hard rock.

It should be noted that when air is turned off, the machine first stops drilling and the air in the column maintains static pressure for some time. It can, however, be exhausted rapidly if desired.—*Eng. and Minn. Journal.*

PAINTINGS DESTROYED BY AIR AND GASES

One of the reasons that the ancient paintings have lasted so long as compared with some of the modern is the fact that the condition of the atmosphere in a modern city is so totally different now from what it was prior to the invention of some of our modern conveniences. For instance, in the city of New York the air contains a perceptible amount of sulfuric acid, due to the burning of hard coal. In the city of Pittsburgh and in the city of London the air contains other acids, and coal dust in addition. The influences of coal gas and of the products obtained from burning illuminating gas are sufficient to have a serious effect on paintings. Then, again, light and darkness are important factors in the preservation or destruction of pictures. Light bleaches and darkness blackens, and a painting which remains in a dark corner for six months turns yellow wherever oil, or an oil varnish, was used on it.

In restoring paintings one of the simplest methods, and one of the most efficient is, after wiping them free from dust and dirt, to place them in the bright sunlight for two or three days, and the sunlight will bring back the colors, excepting such modern lake colors as are faded by the sun, in all their pristine glories.

BOILED CABBAGE.

Another destructive agent to paintings in homes is the gases derived from the cooking of vegetables. Certain veegtables contain a large amount of sulphur, which is easily liberated, particularly in the presence of vinegar, and this sulphur affects the colors, particularly those containing white lead, lead pigments, and others. To a very large degree varnishing preserves paintings from the influence of gases, but, of course, the varnish used must not be made with a drier which contains any chemical affected itself by gases.

Then there is the interaction of one color upon another. Ultramarine blue, which is perfectly permanent by itself, when mixed with flake white and subjected to the influence of an acid gas changesin color from a sky blue to a dirty brown.—*Maximilian Toch, before Franklin Institute.*

The Tonopah and Tidewater Railroad has completed its twenty mile branch line, called the Death Valley Railroad, across the Funeral mountains, from Death Valley junction to the edge of the valley.

THE ENGINEER'S THE BLOKE

BY ROBERT T. GEBLER.

You can rave about yer bloomin' Tommy Atkins on parade
And yer lady-like lieutenants on the Mall.
You can talk about your gunboats, yer rifles and yer camps
And yer heroes in the rain of leaden ball.
But the bloke I doffs me hat to
Didn't fight the sly mulatto
But he was in the battle just the same.
He's the bloke that planned yer bridges,
Built yer roads across the ridges,
To let Tommy Atkins march into the game.

With 'is transit or 'is level he would work to beat the devil—
The devil of a Kaffir, sir, I mean—
But the blokes as write the stories never pass 'im any glory
And they never throws 'im on the movie screen.
Out there 'e is a plannin'
And a river 'es a spannin'
As 'e gets the place in order fer the fair;
But the 'eathen start a shoutin':
They've fergotten all about 'im
And the history won't say that he was there!

Yer millionaires cut capers, get their pictures in the papers
And the public then begins a bloomin' 'owl
'Bout the aqueducks 'en highways, the railroads and the byways
An' big jobs like the Panama Canal.
But as I've often read it—
The bloke who gets the credit
Is not the dusty khaki'd engineer;
But the guys wot 'ave the shillin's
Get in first on all the killin's,
Of the lad who turned the trick we never 'ear.

So I think when I am ridin' down to Dover, or a glidin'
In a taxi 'cross the bridge in Lunnon town.
Of the lads who built the town, sir, and the sewers under groun', sir.
The sea wall and Suez and did 'em brown.
But they never sings 'is praise, sir
In the papers nowadays, sir;
'E never gets the credit that's 'is due.
But the fellers with the money
Wouldn't get the praise and honey
If the engineers wern't there to pull 'em through. —*Engineering News.*

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THE SLOW ADVANCE OF TUNNEL RECORDS

The planning of new railroad tunnels goes on continually, both for the straightening, regrading and general improvement of existing trunk lines and in the building of lines entirely new. Even in Europe, whose transportation lines we are apt to think of as more or less completely finished, they being more carefully planned to begin with, we still record at frequent intervals the planning, the beginning of construction, the holing-through or the completing and opening to traffic of new tunnels one after another, and in America the same story is told more frequently, continuing without end.

In our present issue we give a brief account of the making of a new American speed record in tunnel driving. Although such records are not fairly comparable, since so many conditions vary, both as to the actual work to be done, the nature of the rock, etc., and also as to the men, means and methods employed, still, after all allowances are made, it is not altogether satisfying to note a difference of 20 per cent. or more between the European and the American results.

The American method of driving by a top heading, at least for long tunnels, and when, as is generally the case, speed is the most imperative demand, seems to have been more or less discredited, and other methods are being adopted. In a 2½ mile tunnel of recent date, through the Cascade Mountains near Seattle, the European bottom heading plan was followed, while at the Rogers Pass 5 mile tunnel we have the novelty of a pioneer parallel independent tunnel, which not only pays for itself but saves more than that in the actual cost of the main tunnel.

Both of these methods give the one great advantage of allowing the work of cutting the bulk of the rock in the main tunnel to be carried on at several faces at once, thus dividing up this heavier work, and enabling it always to more than keep pace with the advance of the first heading, the speed record for the entire job depending upon the latter as the pacemaker.

We may say that undoubtedly the general tunnel driving speed has increased, and we may be confident that it will continue to do so, but our progress in this particular is not what should have been expected from the great and rapid advances in working speeds in lines

with which the tunnel work is closely associated.

For all outdoor work in rock breaking and rock handling, with the powerful explosives now employed, the heavy steam- or air-actuated shovels, drag lines, overhead conveyors, high capacity dump cars, unloading plows and similar devices, speeds have doubled and doubled again, but the drill in the heading shows no such great jumps in achievement. The substitution of the light, quick handled one man drill has done much, but much more is required to keep up this end of the work, and here we must be on the alert to seize whatever chances may develope.

There are tunnels innumerable, some definitely planned, some only thought of, and some out of sight beyond that, which only await quicker and cheaper methods of tunnel construction. Tunnels of great length, the last objection to which has been removed by the advent of electric traction, offer the solution to many of the urgent problems of the many mountain divisions when the costs of construction and the time required cease to be prohibitive.

THE BUREAU OF MINES ON MINE EXPLOSIONS

In his annual report to the Secretary of the Interior, Director Joseph A. Holmes, of the United States Bureau of Mines, states that excellent progress has been made during the past fiscal year in the investigations of the explosibility of coal dust, at the experimental mine near Bruceton, Pa.

Probably the most important feature of the year's work was the development of four types of explosion-stopping devices in which rock dust is used, as follows: Box barriers, concentrated barriers, ventilating-door barriers, and ventilation-stopping barriers. The barriers were tested in strong and in weak explosions and were effective in preventing propagation of flame beyond them. Demonstrations before mining men led to inquiries from a number of companies, with a view to the erection of the devices in mines.

The results of the tests at the experimental mine have shown the value of watering and of steam humidifying systems, and the peculiar merits of rock dust, both when distributed throughout the mine and when used as barriers for limiting explosions.

Four great explosions occurred during the year, as follows: One in the Stag Canyon mine, at Dawson, N. Mex., October 22, 1913, resulting in the death of 263 men; one at Acton, Ala., November 18, 1913, in which 24 men were killed; one at the Vulcan mine, New Castle, Colo., December 16, 1913, in which 37 men were killed; and one at Eccles, W. Va., April 28, 1914, in which 181 lives were lost. The general ventilation in most of the mines involved in explosions was good, but the defect in certain mines was in permitting the local accumulation of gas through not bratticing up to the face of gaseous entries or working places. One of the great disasters was probably caused by the use of dynamite for blasting, and by disobedience in firing a shot or shots when miners were in the mine, in spite of the fact that an outside shot-firing system had been installed.

Other lesser disasters occurred during the year. Many shot firers lost their lives in the Pittsburg, Kans., district, and in Oklahoma, Indiana and Iowa. Although the system of employing shot firers to fire the shots when all others are out of the mine lessens the number of deaths, yet in many districts the methods of shot firing employed are still so extremely hazardous that only the most reckless men are willing to act as shot firers.

Director Holmes strongly urges the purchase by the Government of the grounds on which the experimental mine is situated. He declares that the Bureau of Mines should own these grounds, now merely leased, in order to safeguard the large expenditure already made in developing the mine thereon and equipping it with expensive appliances.

Looking to the future, the Director observes that, despite the progress made in ascertaining the nature of mine explosions and in devising methods of prevention, they still continue to occur, and it is to be feared that complete prevention will be difficult, owing to the inherent difficulty of eliminating errors of observation, judgment, or understanding from among miners or mine officials. Thus, one of the shocking disasters of the past year was brought about because of one man's willingness to risk the sacrifice of not only his own life but the lives of many others in order to gain a few tons of coal. It is difficult to meet such a case, and yet with the progress that is being made in the methods of pre-

venting or limiting explosions, it is certain that hereafter in a well-protected mine properly cared for there will be much less danger of a widespread explosion.

THE IMPORTANCE OF CORRECT METHODS IN PRIMING DYNAMITE

A great many blasters think that the priming of a dynamite cartridge is of very little importance—if the dynamite goes off, that is all there is to it. It is not widely known that the success or failure of a good many blasts depends on the position of the detonator—blasting cap or electric blasting cap—in the dynamite. Not only the amount of work done depends in a large measure on the priming but also the safety of the loading operation is affected in many instances by the position that this detonator occupies. Many accidents have occurred and many men have been killed in loading holes with a primer made so that the detonator became jammed or wedged in the hole and exploded when the blaster endeavored to force it down.

The points to be borne in mind in making a primer are the following:

The detonator, and by detonator is meant either a blasting cap or electric blasting cap, must be in such a position that it cannot become jammed in the bore hole.

The detonator must be in such a position that it will not be struck by the tamping stick.

The detonator must be fastened to the cartridge in such a way that when the wires or fuse are held in one hand by the blaster, and the cartridge seated with a tamping stick held in the other hand, the detonator will not pull out.

The detonator must be entirely embedded in the dynamite.

The loaded end of the detonator, or the closed end, or the "business end' should point toward the bulk of the charge, not away from it. The detonator should not be secured by metal wires, etc.

With an electric blasting cap, the wires should not be fastened on with a half hitch, for although this practice is very common, there is always a chance of a short circuit occurring, especially when high voltage power currents are used for firing.

With blasting cap and fuse, the fuse must not come in contact with the dynamite except for about a half inch next to the cap. "Lacing" fuse through dynamite causes more burned charges than anything else.

The maximum detonating effect of a blasting cap or electric blasting cap is out from the closed end. If you place a dozen cartridges of dynamite, end to end in a straight line on the ground and fire a blasting cap in the end cartridge, with the blasting cap pointing towards all the other cartridges, the entire line will go off, but if you put this primer in the middle of such a line, some of the cartridges back of the detonator, that is, those away from which the detonator is pointed, will often fail to explode. If you put the primer cartridge at the end of such a line, pointing it away from the line, that is, pointing it towards the open air, generally the primer only will explode. This does not always happen in a bore hole, because there the explosive wave is strongly confined, but this shows a tendency of the dynamite, which is in the opposite direction from the closed or "business end" of the detonator, to misfire. Several years ago this was demonstrated to a sceptical individual in a quarry shot where there were 27 holes, each hole containing from 19 to 21 cartridges of dynamite; 13 of the holes having the detonator in the next to the last cartridge and pointing downwards, that is, towards the bulk of the charge; the rest of the holes having the detonator in the same cartridge, that is, the next to the last, but reversed, pointing upwards. These holes were all thoroughly tamped with sand and fired at the same time. While all the dynamite in both sides exploded, where the detonator pointed downwards the rock was broken and cleared from the ledge below the bottom of the holes; where the detonator was pointed upwards, about one-third of the distance from the bottom of the holes upwards, the rock was broken up but left in place. This showed that when the detonator pointed downwards, the full power of the dynamite was realized; where the detonator pointed away from the bulk of the charge, the full power was not realized but a great deal was wasted.

When a cartridge of 40 per cent. straight dynamite is suspended vertically in the air, and a blasting cap supported at right angles to it, and pointing directly at it is fired, the dynamite will explode at a distance of 24 inches from the blasting cap, but if a cartridge and blasting cap are hung parallel with each other,

that is, the blasting cap pointing either straight up or straight down and parallel to the dynamite cartridge, so that it does not shoot directly at the cartridge, the dynamite will not explode until it is brought to a distance of 15 inches or less. When the blasting cap is horizontal and the cartridge of dynamite hung vertically and the cap supported at the level of the middle of the dynamite cartridge but pointed so that it does not point directly at the dynamite but a little to one side, this distance where an explosion occurs is lessened still more. When the cap is pointed directly away from the dynamite cartridge, it will not explode the dynamite cartridge every time even when within four inches of it.

The ideal primer with an electric blasting cap would be one where the detonator lies directly in the axis of the cartridge near the middle, and the wires secured to the cartridge, in such a way that they could not possibly pull out, by some strong non-conducting material like string. By using a curved puncher it is possible to get an electric blasting cap almost in this ideal position, where it may be held in place securely by taking a half hitch with a piece of string around the wires, is then carried once or twice around the dynamite cartridge and tied tightly with a square knot.

Another way of priming with an electric blasting cap without using string is to punch a hole through the cartridge about two inches from the end and lace the electric blasting cap through this and insert it in the side of the cartridge.

With short wires, four feet or less, the ends may be passed through this hole after the cap is inserted in the cartridge, but with two long wires is apt to either make the hole so large that it does not make a secure fastening, or it may even cut the cartridge in two.

With blasting cap and fuse, inserting the blasting cap in the side of the cartridge about one-third from the top and tying it tightly with one or more pieces of string, keeps the cap away from the tamping stick, and if carefully done with a curved puncher, places the cap almost in the axis of the cartridge.

The orthodox method of opening up the paper at the top of the cartridge, punching a hole in the dynamite, inserting the cap and fuse into that, and then tying the paper down around the fuse, gets the blasting cap in a good position but is a difficult operation to perform on account of the tendency of the string to slip off the paper and the difficulty of getting the string tight enough to prevent the fuse from pulling out. It also is liable to kink the fuse abruptly if the primer is seated firmly with the tamping stick.

Dynamite when strongly confined in a bore hole burns very raipdly when it is ignited and on this account the lacing of the fuse through the dynamite cartridge is a practice which is strongly condemned by all explosive manufacturers. It seems strange that very much of the dynamite would burn before the cap would explode but the fact is, dynamite burns very much more rapidly when confined than when in the open, and it has been known to burn up entirely in a bore hole which contained a perfectly good cap without any of the dynamite exploding, the cap of course exploding and doing no work. Burning dynamite makes a large quantity of exceedingly poisonous fumes, and a number of fatal accidents have occurred from dynamite burning up in the bore holes in mines and tunnels, due either to lacing the fuse through the cartridges, or from other causes, such as matches, sparks or burning oil dropping into the charged bore holes. These fumes from burning dynamite are so frightfully poisonous that no chance whatever should be taken of a charge catching fire, especially when it so so easy to prevent it by taking the proper care in preparing the primer.

In priming holes where it is necessary to have two primers, one should be near the top, pointing downwards and one in about the middle also pointing downwards. Where three primers are used, place one at the top, one about one-third way down and one about two-thirds way down; that is, equally distant from each other and from the bottom of the hole.

The bane of blasters in mines and tunnels is the smoke and fumes from the explosive, and while no explosive has yet been invented which does not give off more or less irritating fumes, the quantity of fumes given off can be materially decreased by insuring complete detonation of the charge by using the strongest obtainable blasting cap or electric blasting cap, by inserting the primer in either the last or next to the last cartridge in the hole, and placing the detonator so that the "business end" points towards the bottom of the hole, and by using an adequate amount of good tamping material on top of the explosive charge. The reason why it is advisable to

place one cartridge on top of the primer is that it serves to cushion the primer from the tamping stick when used for packing the tamping. The stronger the confinement and the larger the detonator, the more perfect the explosion will be, and the less amount of noxious fumes will be given off.—*DuPont Magazine.*

JACKHAMER SUPERSEDES HAND AUGER DRILL

Charles H. Claypool, superintendent of the Cavour Mining Company, Virginia, Minn., reports some interesting results from the use of the Jackhamer drill on the Mesabi Range.

Previous to the introduction of the air auger, the system employed at the Cavour mine was that generally used on the Mesabi. The miners drilled and blasted their own ground, put in their own timber with the help of a timber man, mucked up the ore and trammed it to the pockets. Hand augers were used in drilling, and two miners could drill a round of five 6-ft. holes in about two hours, the Cavour ground being somewhat harder than the usual Mesabi ground. The average speed was about 1 ft. in 8 min. Blasting was done at the noon hour and at the end of the shifts, and occasionally during the shift. In places where the air circulation was not good, considerable time was lost in waiting for the air to clear up. When working two shifts, five gangs of miners each, the production ran about 3.75 tons per man for every man employed, this low figure being due to the small number of producers compared to the number of nonproducers employed.

The introduction of the air auger permitted the system to be changed so that muckers were employed instead of miners. Under the new scheme, all the drilling and blasting are done by two men and the timber is all handled and put in by regular timber men. The muckers simply shovel ore and tram it to the pockets. All drilling, blasting, timbering, track work and underground repairs of all kinds are done on the night shift, so that nothing interfers with the tramming and hoisting, which is done only on the day shift.

The advantage in this system of working is that there are special men for each kind of work and each man becomes an expert in his particular duty. As a result, it has been found at the Cavour mine that the powder cost has been reduced over 50 per cent., because the drill men become proficient in placing holes and using powder. The cost of timbering has likewise been greatly decreased. Under the new system, the production per man is about 5.25, compared with 3.75 tons per man with the old system, the total production remaining the same. The drilling speed has increased from 1 ft. in 8 min. to 1 ft. in 1 min. The muckers tram an average of 26 tons per shift per mucker.

The item of labor in drilling has been greatly reduced by the air machines, and while the increase in production per man is probably due largely to the new system of operation, the latter has been made possible only by the use of the air auger.

A PORTABLE GAS EXPLOSION

An accident with fatal results which occurred recently at Hagerstown, Md., and which was reported as an acetylene tank explosion, calls for a somewhat different explanation. The occurrence was in a junk yard where a gas torch was being used for cutting up old material. There was no acetylene in use at the yard when the explosion took place. They were using blau gas and this, being transported in a liquified state, called first of all for a supplementary receptacle for the expansion of the gas before it could be used. A blau gas cylinder had been emptied and was removed. Then the men of the yard by mistake, attempted to attach an oxygen cylinder. As the fittings didn't match, they went to the extreme of wiring the cylinder onto the connection. The open valve in the oxygen tank allowed the oxygen to mix with the blau gas in the expansion chamber. They ignited the torch, which in a moment blew itself out. They again ignited the torch, and this time a flash-back occurred into the expansion chamber and the oxygen and blau-gas mixture exploded with serious results. These statements clearly show that the human equation entered, into this accident to the extent of 100% and that no cylinder of compressed gas of any kind exploded.

NOTES

The Münster Grenchenberg Tunnel near Bern, Switzerland, was holed through on October 27, 1914. The tunnel is 5⅜ miles, or slightly longer than the Hauenstein base tunnel, which was holed through July 10. The new tunnel is located north of the Lötschberg

tunnel on the main route to Italy via. the Simplon tunnel. Its construction has taken 3½ years and its cost is about $5,000,000.

A single blast on the shores of San Francisco bay recently broke 166,250 tons of rock in a suitable condition for removal by steam shovels. There were eight holes and each pound of powder broke 9.5 tons of rock.

The longest railway tunnel in India is that piercing the Khojak Range between Quetta and Chaman, near the northwestern frontier, which has a length of 12,870 ft. The second longest tunnel, 3,900 ft. is now being driven on a double-track cutoff between Thana and Diva. This pierces the Parsik Hill and reduces the distance 11 miles as compared with the present line, which makes a detour around the hill

From experience with tread mills in British prisons, we know accurately the mechanical equivalent of hard labor. It is a climb of 8,640 ft. in 24 hr. If the average weight of a man is 150 lb. he can do approximately 1,200,000 ft.-lb. of work each 24 hr. A horsepower for 24 hr. is approximately 48,000,000 ft.-lb. It would require 40 men to develop a continuous horsepower, and their wages would would be $80 per day, or $28,800 per year.

The use of a fluid composed essentially of glue and calcium chloride in solution, for laying coal dust, has been tested on a commercial scale at a Newcastle colliery with, it is affirmed, effective results. The liquid is placed in a specially designed 100-gallon tank, mounted on wheels, and is applied in the form of a spray, at a cost (which does not appear to be prohibitive), of about fifty cents a yard per annum. One application suffices for three months. Besides, successfully accomplishing the primary purpose of laying dust, the liquid acts also as a preservative of timber.

The space available in the lower portions of five reinforced-concrete chimneys completed recently for the Havana Railway, Light & Power Company, Havana, Cuba, has been utilized for storage rooms. As all chimneys are located inside the power house to economize on space two storage rooms were provided in each chimney. At an elevation 18 ft. above the top of the foundation a floor was placed and the chimney was provided with a doorway. Another floor was built giving 36 ft. above the top of the foundation another storage room.

After air enters a mine, the breathing of men and animals, burning of lamps, decay of mine timbers, and firing of shots take oxygen from the air and add carbon dioxide to it, but in well ventilated mines the air depletion from these causes is small. Much more important changes are those caused by oxygen being taken from the air by the coal; and by gases from the coal, the roof, and the floor being added to the air.

The use of moving pictures in the publicity field of the machine industry is not new, but examples of its extension are always of interest, and one firm in Hull, England, making oil-mill and other machinery for export, has a "private picture palace" for showing its machinery in operation under various circumstances. An important variation on this scheme is to send the films abroad, with or without a salesman, for the benefit of customers who might never have an opportunity to see the actual operation of the machinery in other countries.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 1.

1,118,987. TRAIN-STOPPING APPARATUS. Frederick Willock, Scranton, Pa.

1,118,994. AIR-BRAKE. Edward W. Woolley, Jersey City, N. J.

1,119,007. METHOD OF AND APPARATUS FOR DRAWING GLASS. Robert L. Frink, Cleveland, Ohio.

1,119,018. CUSHIONING DEVICE FOR VEHICLES. Theodore A. Klenke and Sigwood Olsen, New York, N. Y.

1,119,020. PNEUMATIC SUSPENSION DEVICE FOR SHAFT-DRIVEN MOTOR-VEHICLES. Theodore A. Klenke, New York, N. Y.

1,119,047. ARTIFICIAL ABDOMEN FOR COMEDIANS AND OTHERS. John Woodard Simmons, Ozark, Ala.

1. A means for the purpose described, comprising a bag of semi-ovate form when inflated, with one face concave, a container for compressed fluid, a connection for coupling the container to the bag for its inflation, and means for the deflation of the bag separate from the means for its inflation, said inflating and deflating means being located to permit their manipulation without exposure to view.

1,119,114. CARPET-CLEANING MACHINE. Lincoln L. Porter, Oskaloosa, Iowa.

1,119,198. PNEUMATIC ROCK-DRILL. CLARK J. SMITH, Ottumwa, Iowa.

1,119,214. MILKING-MACHINE. CHARLES M. ANDERSON, Waterloo, Iowa.

1,119,224. PNEUMATIC JACK. JOHAN HENRY BEHRENS, Camden, N. J.

1,119,236. AIR-PRESSURE INDICATOR FOR PNEUMATIC TIRES. CARL O. BRENNER, Descanso, Cal.

1,119,242. RAILWAY-BRAKE MECHANISM. EDWARD CARRAU, Cathlamet, Wash.

1,119,425. FLUID-PRESSURE MOTOR. EDMOND GUERIN, Maisonneuve, Quebec, Canada.

1,119,473. PROCESS FOR TREATING ORES. WILLIAM A. THACHER, Lake City, Colo.

1. The process of treating sulfid ores which consists in causing a stream of compressed air to pass through a charge of ore and acid in a closed vessel, and causing a spray of the charge to be spread across the surface of the charge in the path of the acid fumes and gases rising from the charge.

1,119,520. PROCESS FOR PASTURIZING LIQUIDS. CARL KRUG, Frankfort-on-the-Main, Germany.

1. A process of pasteurizing liquids in bottles in a closed chamber, consisting in heating the chamber by supplying steam into the same, in shutting off the supply of steam, in supplying compressed air through and into the top of the chamber while the liquid in the bottles is being heated by the steam in the chamber, and in then opening an outlet of the chamber, whereby the compressed air is preheated while the chamber is being heated by the steam, subsequently ejecting the hot mixture of steam and air out of the chamber and gradually cooling the bottles.

1,119,522. OILER. ROBERT GEORGE MCDOWELL, Walkerville, Mont.

1. In an oiler for pressure fluid operated tools having a fluid supply pipe, a closed oil reservoir having an oil supply passage leading to said fluid supply pipe, a hollow valve for said passage having a hollow valve stem affording communication between said fluid supply pipe and said oil reservoir and a spring for resiliently closing said valve, the said spring being of slight tension to permit the opening of said valve from the vibration of said tool.

1,119,524. PNEUMATIC PORTABLE RECIPROCATING SAWING-MACHINE. GEORGE E. MORRIS and OSCAR F. OLIVER, Jersey City, N. J.

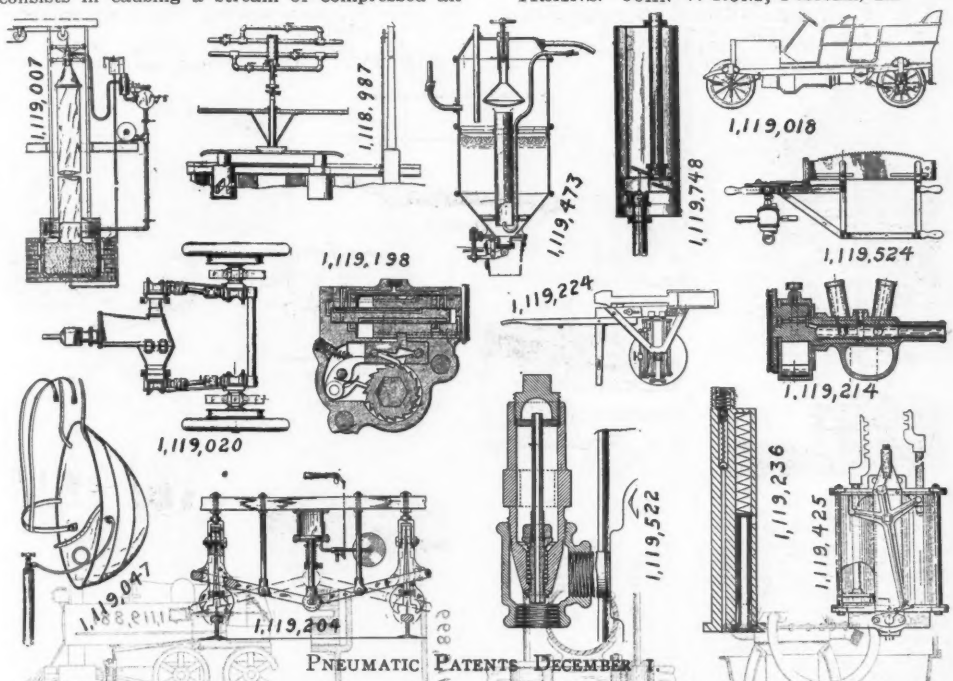
1,119,713. CENTRIFUGAL AIR-COMPRESSOR. SANFORD A. MOSS, Lynn, Mass.

1,119,748. PUMP FOR VACUUM-CLEANERS. ALVIN O. CARMAN, Tekonsha, Mich.

DECEMBER 8.

1,119,834. AIR-PUMP. ALBERT F. KRAUSE, Buffalo, N. Y.

1,119,881. AUTOMATIC SAFETY-STOP FOR TRAINS. JOHN V. RUND, Pesotum, Ill.



PNEUMATIC PATENTS DECEMBER 1.

1,119,889. APPARATUS FOR COMPRESSING AIR. STEPHEN G. SKINNER, Wilmette, Ill.

1. In an apparatus for compressing air which is adapted to be operated by the alternate suction and compression created within an internal combustion engine cylinder, the combination with a cylinder adapted to be connected with the engine cylinder, a piston within said cylinder, a movable compression chamber carried by said piston, a stationary piston for said movable compression chamber, and a valved passage whereby air admitted to said cylinder to operate the movable piston therein is passed to said compression chamber behind the piston therein and thence around said piston upon the next downward movement of said compression chamber.

1,119,899. TRIPLE-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

1,119,907. PIANO-PLAYER MECHANISM. WILLIAM T. WAITE, Laporte, Ind.

1,119,929. PROCESS FOR SECURING THE PRECIPITATION OF THE RARE-METAL OXIDS. ROYAL S. DAVIS, Newmire, Colo.

1. A method of securing the precipitation of the oxids of the rare metals, from solutions containing the acids, which consists in applying

super-atmospheric pressure to the acidulated and heated solutions.

1,119,960. PROCESS FOR MAKING INK. ROBERT HOCHSTETTER, Cincinnati, Ohio.

2. The process of manufacturing ink, which consists in mixing a pulp color with a varnish in a suitable closed vessel, at the same time subjecting the mixture to the action of an air exhausting device adapted to reduce the pressure in said vessel, and applying heat to said vessel adapted to vaporize the water in the mixture at the reduced pressure.

1,119,972. ENGINE, AIR-PUMP, Etc. FRITZ W. MACHLET, Elizabeth, N. J.

1,120,011. PNEUMATIC ANTIVIBRATION DEVICE FOR AUTOMOBILES. GEORGE WILLIAM BELL, Liverpool, England.

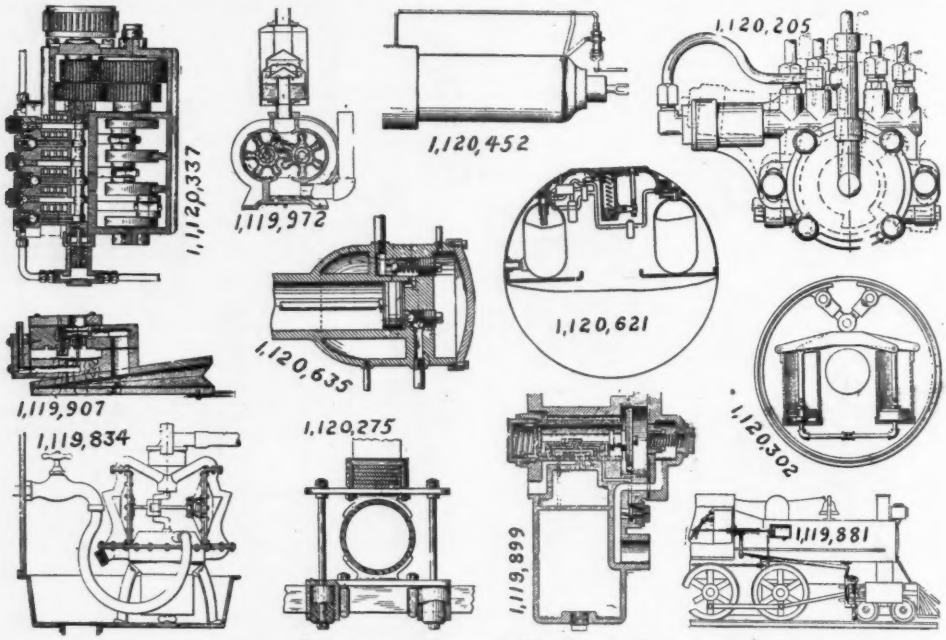
1,120,130. VACUUM CLEANING MACHINE. SECONDO L. CASELLA, New York, N. Y.

1,120,205. STARTER FOR GAS-ENGINES. WILLIAM KELLY, Detroit, Mich.

1,120,621. FLOATING SUBMARINE MINE. JOHN GUNNAR LINDMARK, Eskilstuna, Sweden.

1. A floating mine comprising in combination, a regulating vessel, a pressure vessel, an intermediate vessel, connections and valve means for leading air from said pressure vessel to said regulating vessel through said intermediate vessel, and automatic hydrostatic means for controlling the action of said valve means, said valve means and said automatic means being so arranged as to connect said pressure vessel with said intermediate vessel when the mine is above a certain depth and to connect said intermediate vessel with said regulation vessel when the mine is below a certain depth, and being arranged also to cut off said intermediate vessel from said pressure vessel at the time the intermediate vessel is connected to the regulating vessel.

1,120,635. COMPRESSOR FOR AMMONIA SYSTEMS. JOHN L. VIDAR, Los Angeles, Cal.



PNEUMATIC PATENTS DECEMBER 8.

1. In an apparatus of the kind described, the combination of a source of compressed air, a multiple cylinder gas engine, a distributer, a passage leading from each of the cylinders of said gas engine to said distributer, a valve adapted to open and close all of said passages, a valve adapted to be actuated by the operator between said source of compressed air and said distributer, and means whereby the pressure of the compressed air actuates the first named valve to open all of the passages between said distributer and the cylinders of the engine when the valve between the reservoir and distributer is open.

1,120,275. PNEUMATIC DEVICE FOR THE RUNNING-GEARS OF VEHICLES. JOHN CALDWELL, New York, N. Y.

1,120,302. AIR-BRAKE. ARTHUR J. GAULIN and ARTHUR VAN WYKE, Charleston, Mass.

1,120,337. STARTING-MOTOR AND COMPRESSOR. WALTER H. SHIMPF, New York, N. Y.

1,120,452. FLUID-PRESSURE-RELEASING VALVE. ARTHUR O. CURRY, San Bernardino, Cal.

DECEMBER 15.

1,120,673. APPARATUS FOR INHALATION PURPOSES. HUGO BAYER, Vienna, Austria-Hungary.

1,120,818. DEVICE FOR WASHING AIR. ALFRED C. JOHNSON, Winters, Cal.

1,120,828. FUEL-SUPPLY SYSTEM AND STARTER FOR EXPLOSIVE-ENGINES. BENJAMIN F. LOWRY, Austin, Tex.

1. A fuel supply system including an internal combustion engine, a fuel inlet communicating therewith and an exhaust outlet leading therefrom, a storage tank communicating with the said engine fuel inlet, a compressor communicating with and adapted to deliver compressed gases to said storage tank, said engine exhaust outlet communicating with said compressor, fuel and air pipes communicating with said compressor, a pressure relief valve communicating with said exhaust pipe, and a governor controlling the pressure within said storage tank.

1,120,833. FLUID-MOTOR AND RETARDING DEVICE THEREFOR. JAMES F. MCELROY, Albany, N. Y.

1,120,986. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.
1,121,218. AUTOGENOUS BURNER. ERNEST WISS, Griesheim, Germany.
1,121,297. ASPIRATING APPARATUS. HENRY J. SCHMITT, Pittsburgh, Pa.
1,121,402. COMPRESSED-AIR WATER ELEVATOR. HORACE L. RILEY, Richwood, W. Va.
1,121,404. STOPPING APPARATUS FOR MOTOR-CARS. HENRY C. RUF, Easton, Pa.
1,121,474. LIQUID-FUEL FURNACE. GEORGES EUGENE CANHAC, St-Denis, France.

1. In a furnace provided with a fuel burner, the combination therewith of means to supply a blast of air to the jet issuing from the burner, said means provided with an opening located directly above the jet and extending throughout a part of its length, said opening substantially conforming in shape to the horizontal cross section of the jet.

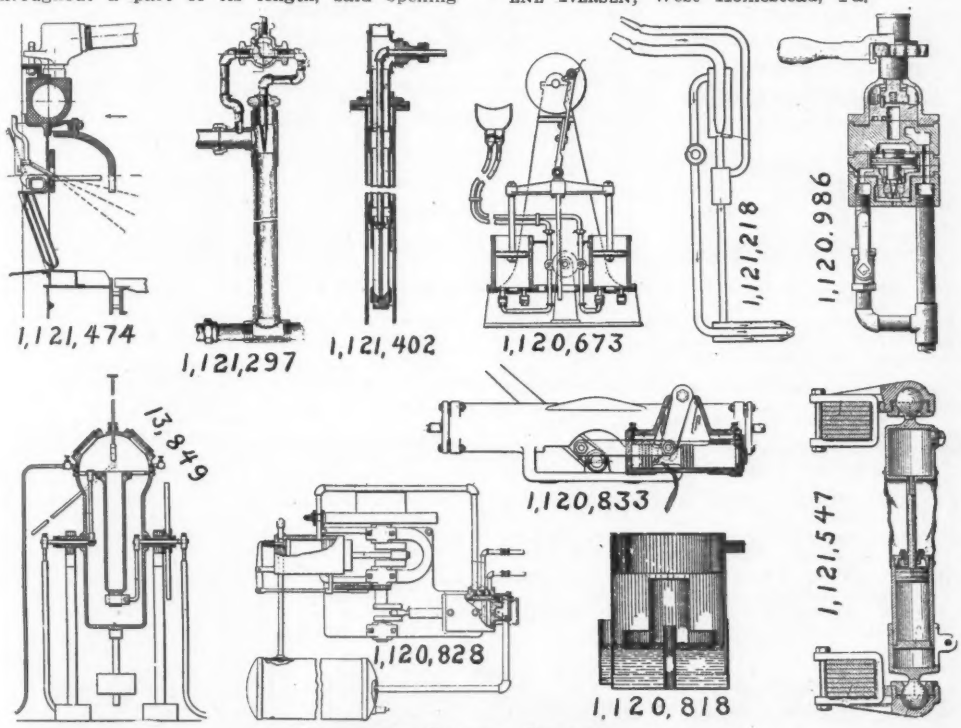
1,121,547. SHOCK-ABSORBER. ARTHUR A. BARBER, Detroit, Mich.
13,849. (REISSUE). APPARATUS FOR MELTING AND MIXING METALS IN VACUO. WILLIAM SPEIRS SIMPSON, London, England.

DECEMBER 22.

1,121,608. APPARATUS FOR FEEDING MOLTEN GLASS. ORVILLE A. BRIDGES, Zanesville, Ohio.
1,121,710. TRACK-SANDING APPARATUS. ALBERT H. CARNES, St Louis, Mo.
1,121,810. PNEUMATIC-STACKER HOOD. AUGUST P. DETERMANN, Lyons, Iowa.
1,121,845. APPARATUS FOR SUPPLYING HUMIDIFIED AND SCENTED AIR. FREDERICK W. KALLUSCH, Long Beach, Cal.
1,121,956. GOVERNING MECHANISM FOR CENTRIFUGAL COMPRESSORS OPERATING IN PARALLEL. RICHARD TROGER, Charlottenburg, Germany.
1,122,039. PNEUMATIC DUST-COLLECTOR JOSEPH J. SMITH, New York, N. Y.
1,122,085. COMPRESSOR. ADDELBERT DUDGEON, Latrobe, Pa.
1,122,099. PORTABLE LIQUID-SPRAYING APPARATUS. WILLIAM H. GILMOUR, Liverpool, England.
1,122,105. MOLDING-MACHINE. JOHN A. GUY, Watervliet, N. Y.
1,122,142. APPARATUS FOR DRYING MILK. JOHN D. MCINTYRE, New York, N. Y.

DECEMBER 29.

1,122,253. AIR-BRAKE SYSTEM. HARRY D. CARROLL, Norristown, Pa.
1,122,395. COMPRESSOR-UNLOADER. LORENZ IVERSEN, West Homestead, Pa.

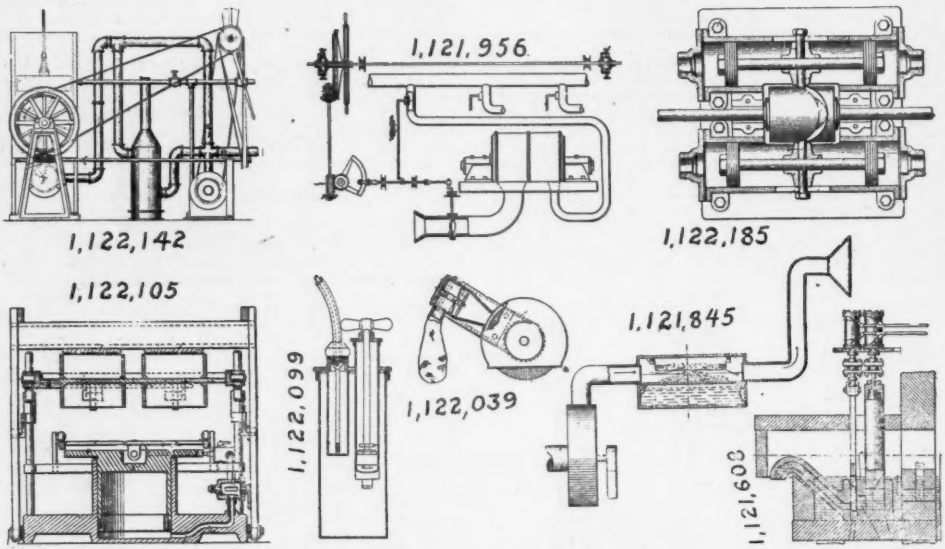


PNEUMATIC PATENTS DECEMBER 15.

1. The combination of a compressor cylinder, a relief valve in communication with the cylinder intermediate the cylinder ends, automatic means for operating the relief valve when predetermined cylinder discharge pressure has been attained, and a piston within the cylinder and adapted to close the communication between the cylinder and valve during a portion of the piston stroke.

1,122,421. PNEUMATIC PROJECTOR FOR CONFETTI AND THE LIKE. THOMAS G. REDINGTON, Medfield, and JOHN L. E. PELL, Great Barrington, Mass.
1,122,436. AUTOMATIC SLACK-ADJUSTER. RICHARD C. SWARTZWELDER, Edgewood, Pa.
1,122,566. PORTABLE FIRE-ESCAPE. WALTER F. BAILEY, Los Angeles, Cal.

2. In a fire escape, a plurality of alined cylinders formed with ports in their ends, pistons in said cylinders, a crank shaft connected to said pistons, a cable carrying reel geared to said crank shaft, a portable frame supporting the cylinders, crank shaft and reel, and a valve for controlling the passage of air to and from the



PNEUMATIC PATENTS DECEMBER 22.

cylinders through the ports, whereby the speed of rotation of the reel may be varied or its movement inhibited, comprising a cylinderical valve member formed with a plurality of longitudinally extending grooves of various cross-sectional areas adapted to be moved in and out of register with the ports on the rotation of the valve.

1,122,629. PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,122,630. FLUID - OPERATED PERCUSSIVE TOOL. CAID H. PECK, Waverly, N. Y.

1,122,638. PRESSURE-CONTROLLED VALVE. WARD RAYMOND, Easton, Pa.

1,122,877. PNEUMATIC TRANSMISSION. FRANK A. DOWLER, Lawrence, Kans.

1,122,886. VACCUM MASSAGING DEVICE. THOMAS H. ELLIS, St. Louis, Mo.

1,123,001. FLUID-PRESSURS BRAKE MECHANISM. RICHARD A. PHILBRICK, Fredonia, Kans.

1,123,114. MEANS FOR MOISTENING THE AIR USED IN EXPLOSION - ENGINES. CHARLES E. DIEHL, Des Moines, Iowa.

1,123,155. ART OF DUST-HANDLING. WHITFORD W. WOODLEY, Elizabeth City, N. C.

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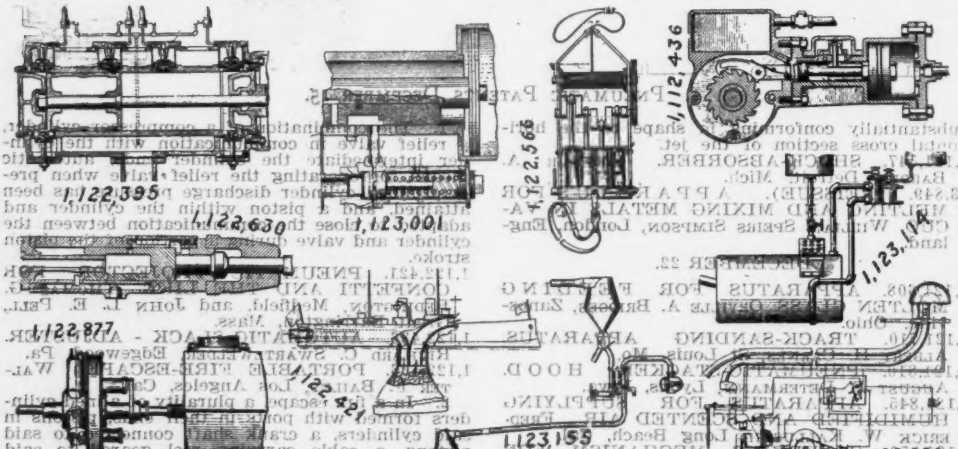

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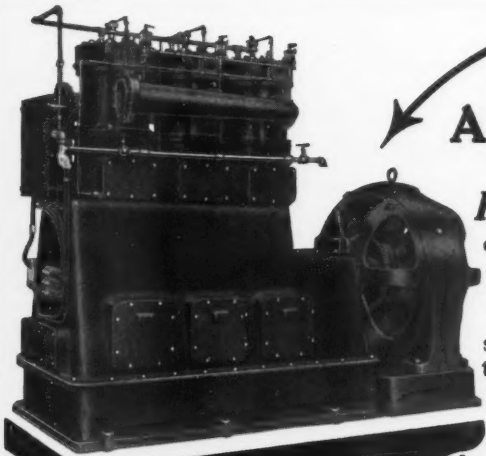

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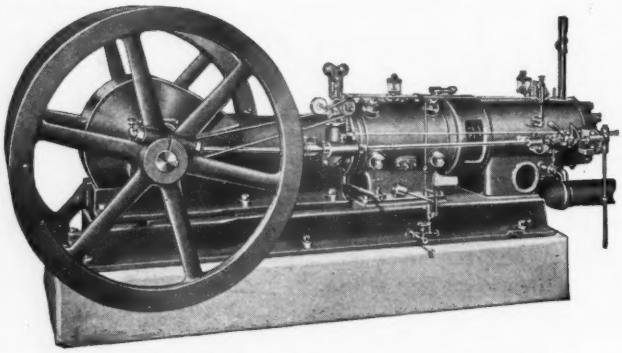

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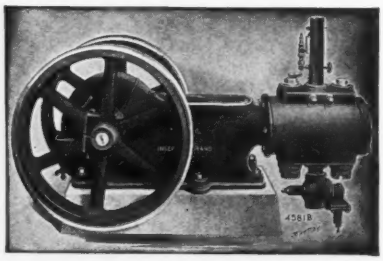

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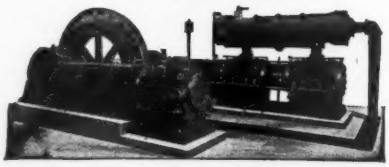

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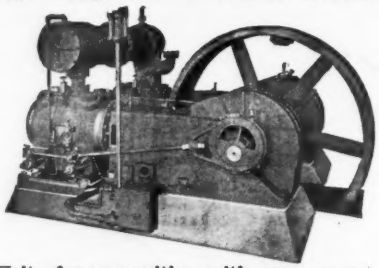

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